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ELECTRICAL WORLD AND ENGINEER.

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THE EDISON SYSTEM IN BOSTON.

Nearly ten years ago an admirable article appeared in our pages by Mr. A. C. Shaw, describing in great detail the growth of the Edison system in Boston. This week we are able to return to the subject and now present an even more extensive article by Mr. E. S. Mansfield on the development and status of the system, which is one of the most important and most conspicuously successful in the country. It is needless to remind our readers that a great deal has happened in the interval between the two articles, and that remarkable changes have swept over the central station industry in the decade—the use of motors, the employment of storage batteries, the rise of the alternating system, the perfection of the enclosed arc, the general consolidation of local plants. Throughout all these mutations the Edison system in Boston has remained under one vigilant governing intelligence, and may fairly be said that President Edgar has made his influence felt in every branch of the work under his care. Even as we write, the vast arc lighting system in that city is also about passing under his management, presenting further opportunities for economical and profitable direction of the two great properties.

Our readers will readily note for themselves many salient features of interest in the article herewith presented, and will thank Mr. Mansfield for his lucid description and painstaking care in dealing with each part of the system. We venture to point out one or two things that might possibly be overlooked. The station has claims to be regarded as a novelty; in fact, we know of nothing like it. It represents what we might call the "compartment" or "cellular" type. Although three generating plants receive attention in the article, the load is almost wholly taken from the Atlantic Avenue station where the company obtains the best economy. Mr. Edgar has never believed it safe to depend on one station exclusively. Hence, carrying out an ingenious and thoroughly sound idea which he has nursed ever since the original equipment there went in, he has arranged the old and the new station as separate units. They can be operated singly or together; and either is adequate should anything whatever go wrong with the other. "Reserve" has, indeed, been the Edgar keynote, for it was the Boston Edison example which did so much to popularize the storage battery in central station work. As will be noted, the company has gone on increasing its battery equipment right down to the present time, finding in it an element which simplifies the distribution question very materially.

In these days when the alternating system bulks up so notably and, indeed, it may be said, dominates the future, the example of the success of the Edison direct current system in Boston as set forth in the article is worthy of more than usual consideration. It would be interesting to determine exactly, if it were possible, just how much the curious concentric physical shape of Boston has had to do with the result; as well as the character of the buildings and business. They certainly have been well adapted to the Edison system and have been availed of in masterly fashion. It is true that three-phase generation has been resorted to, but as in long, narrow New York, the distribution is practically all direct current, and this permits the important reserve value of the storage battery to come into full play. In other words, the Boston Edison system is evidence of sound eclecticism in the selection of the latest and best methods, and the results are indicated in the increasing angle of the curve showing the growth of load.

THE CONVENTION AT NIAGARA.

We have given our readers so many articles from first to last on the development and utilization of Niagara power, both at the Falls and at Buffalo, that we feel there is no reason to inflict on them again an oft-told tale. Few electrical plants, if any, are so well-known as those at the Falls, where it has now resolved itself merely into a question of expansion along the lines already made familiar. The visit of the National Electric Light Association to Niagara this year is impelled rather by a desire to see the Pan-American Exposition than to traverse again ground that has become so hackneyed in an engineering sense. Still, the beauties of the Falls are ever fresh, especially at this season of the year, and the officers of the Association are to be congratulated on not trying to establish headquarters in Buffalo itself, where the Exposition rush is already making itself felt in higher rates for hotel accommodation. The Exposition is handily accessible from the Falls, and is mightily well worth seeing. We are glad to know that it has served as an inducement to bring out a large attendance at the convention, whose meetings we could wish better attended. The widening range of central station work brings its managers face to face with many new problems of a varied nature, and to their solution, intercourse and exchange of views among those concerned is necessary. We do not recall a single meeting of the Association in all the long years of its existence where a central station manager could not derive great benefit from being in attendance, even if not participating in the discussions. There is still just as much opportunity as ever for the president and other officers to distinguish themselves by service to the industry.

Returning for a moment to Niagara itself, it may be pointed out that while the utilization of the great water power still goes on the long-distance transmission is all the time kept in check by the local demand for current. Mr. H. W. Buck, the electrical engineer of the Niagara Falls Power Company, has lately put the local utilization for that plant at 16,900 horse-power, intermediate utilization 11,500 horse-power, long-distance transmission 18,850 horse-power, which includes 5000 horse-power for the temporary uses of the Pan-American Exposition. There is, of course, the development down the gorge, but all that current again seems to find a ready local market. As a matter of fact, if we want real long-distance work, it is to the extreme West that we must look, although in the eyes of the public Niagara remains, curiously enough, the great exemplification of that kind of engineering.

ELECTRO-CHEMISTRY.

In our correspondence columns appear two interesting letters brought forth by an editorial in our issue of April 27. The purpose of that editorial comment has been successful, in so far as it has elicited this expression of views and debate. We quite agree with Mr. Burgess in so far as regards the requirements of electro-chemical industry and the capabilities of electro-chemists. The object of electro-chemical industry is, of course, to produce chemicals by electric processes at a small a cost and as great an effectiveness as possible. An electro-chemist, in the performance of his industrial work, cannot afford to make researches upon dissociation constants at indefinitely great dilution. He must be essentially an engineer and a man of business. In all this we are entirely on Mr. Burgess' side.

But we must differ with Mr. Burgess, if he takes the position that a trained electro-chemist does not need to be thoroughly grounded in the science of electro-chemistry, or to be familiar with the most recent developments of the German electro-chemical school. We take it that the very best theoretical knowledge, and the most complete laboratory equipment, is only just good enough for the preparatory training of men who are to turn that scientific knowledge to practical account. The process of thorough grounding in the science of any business with the view to a practical equipment for that business should stop only at the point where further expenditure of time and educational effort would tend to narrow rather than broaden the intellectual grasp of the subject. Similarly, when athletes are trained, it is possible to overdo the muscular training by carrying the developing process injudiciously too far. For this proposition of thorough scientific education we stand. The day has gone forever when ignorance of the science of any industry can be either a recommendation or an excuse. We want the highest possible development of theoretical knowledge, as taught in our technical colleges and universities, in the belief that the more we know about the laws of Nature, the better opportunity there will be to utilize them for the benefit of the race and for ourselves.

As far as concerns the aluminum and calcium carbide industries they would not have been capable of development to their present condition, if the sciences of electro-chemistry and electro-thermistry had not been developed to their present condition with the aid of the theoretical man. In other words, the practical results of the electrical industries, at the present time, are partly due to the business men who had sufficient confidence in the practical outcome of the process to invest capital in them, partly to the practical men who used sound judgment and practical experience in the work, and partly to the theoretical men who established laws, principles and sign-posts for the guidance of the practical workers, warning them where they should expect to fail, and indicating where they should expect to succeed. If the experimental researches of such men as have set the stepping-stones of electro-chemistry from Faraday to Nernst had not played their part, the practical men would to-day have been hindered, and would have had to do that work themselves, or given up the quest. We are entirely in sympathy with the views of Mr. Johnson, who lays stress both on the necessity for better theoretical and technical training of the electro-chemists at the outset of their labors, and also upon the practical nature of the electro-chemist's labors.

BLAZE CURRENTS AND LIFE.

In the Proceedings of the Royal Society for March appears a remarkable paper by Dr. A. D. Waller, who states the proposition that in the case of the particular class of vegetable seeds with which he has experimented, namely, beans, the seed is alive if it responds in a particular way to an electric stimulus, and that, on the contrary, it is dead if it fails so to respond. The method of distinguishing consists in placing the bean between a pair of suitable moist electrodes, and sending an electric discharge or impulse through the same, such as the discharge of a one-microfarad condenser, which has been charged by a couple of Leclanche cells. After the electric impulse, the bean electrodes are connected to a sensitive galvanometer. Suitable compensation is introduced to annul any unbalanced e. m. f. which may exist in the circuit prior to the application of the electric stimulus. Two such stimuli are usually given, one in the positive and the other in the negative direction. If the bean is alive, it will give a relatively powerful discharge (about 75 millivolts e. m. f.) usually in the same direction as that of the stimulus, while if the bean is dead, it will give only a relatively feeble polarization e. m. f. (about one millivolt) in the opposite direction to that of the stimulus. The process of disinguishing seems usually to have killed the bean, but in some cases the bean has been successfully planted after the test. The "blaze" e. m. f. set up is by no means a transitory feature,

but after rising suddenly to, say, 75 millivolts, it falls in logarithmic fashion to about 10 millivolts in the course of half an hour. From a theoretical standpoint the subject is highly interesting, since it opens up a wide avenue for the study of the relations between life—that wonderful enigma—on the one hand, and electric actions, so completely capable of measurement and control, on the other hand.

WIRELESS TELEPHONY.

In the London *Electrician* for May 3 an article appears on this subject by Professor E. Wilson and C. J. Evans. Experiments are described, which were made for the purpose of extending the range of induction telephony between suitably separated and opposed induction coils, one of which carried the speech current, and the other of which had a reproduced speech current induced in it. The interest of the experiment lies, however, in the use of a direct-current arc as a telephone relay. Two methods are described, one in which an electromagnet energized by speech currents acts upon a direct-current arc, in such a manner as to slightly deflect it in a vibratory manner, after the fashion of the electric blow-pipe. The direct current thus supplied to the arc undergoes vibratory variation by reason of this influence, and the theory is that the range of variation is considerably magnified by the process. In the other experiment, the lower of the two arc carbons is mounted upon a transmitter, so that its distance from the upper carbon is slightly varied in a vibratory manner, and the influence of this variation upon the direct-current strength is to cause a like but amplified vibratory variation of its strength.

THE COMPUTATION OF TRANSMISSION SYSTEMS.

We are publishing this week a study of certain problems in power transmission that will, we think, be welcome to engineers who are wrestling with them in daily practice. Mr. Baum's method of attack is one which leads to very convenient graphical results, exceedingly easy to apply when once they are put in shape. And the computation which leads up to them is by no means intricate, although it involves necessarily a considerable number of constants, not all of them easy to predetermine. Aside from the convenience of the diagrams, it is a good thing to have emphatically brought to notice the all-important matter of regulation. The truth to tell, regulation is in many instances the one controlling factor in the design of the line, and even of the whole plant, for upon regulation depends the quality of the service, and hence the commercial prosperity of the plant. It profits little to design the line according to the canons of the art for maximum economy of transmission if for one reason or another the regulation is so poor that it becomes difficult to sell the output. And as a matter of fact, poor regulation is for one reason or another the besetting sin of many power transmission systems. It takes no little finesse to design a system so that the voltage on the distributing system shall be nearly uniform and constant, or to run the system to this end after it is installed.

Mr. Baum's diagrams are in a form which displays in a very striking fashion the effects of varying load, and particularly of varying power factor. Take, for example, Fig. 1, a common and comparatively simple case, and note the effect of passing, say, from half load at power factor unity to six-tenths load with a 5 per cent lag. The effect of the regulation is something startling, and it is by no means reassuring to note the trivial effect of change of load compared with that of the shift in power factor. In these days of alternating arc lights such changes are likely to be of daily occurrence, and only the utmost tact and skill can prevent them from producing most evil effects on the voltage of the distributing system. Or suppose some customer starts a big induction motor, which may, in starting, have a power factor not far from 70 per cent, corresponding to a considerable change in the power factor of the system even though the actual amount of energy involved be comparatively small. Down goes the voltage and then the users of incandescent lights begin to raise a justifiable protest. Such diagrams bring out the evil results of shifting power factor in a very striking manner, and point most forcibly to the need of available remedies. At present these are, in general, conspicuously absent. In more than a few plants it has been found necessary to cut apart the transmission and distributing systems by means of motor generators in order to secure immunity from such changes in regulation. It seems a drastic remedy, but it is effective and therefore is endured. Of course, slow changes in load and power factor can readily be controlled by manual regulation at the substation at the price of eternal watchfulness, but sudden changes are likely to catch even the most vigilant operator napping and then there is trouble. Add to such difficulties the effects of unbalancing the load, and it is easy to see that the regulation problem is one of most serious magnitude. As distances of transmission grow longer its solution becomes progressively more and more difficult.

As regards the generating station itself some relief may be had from modern methods of compounding. But while these may be of material assistance, up to the present time there does not appear to be any method in use which will really compound successfully against both change of load and change of power factor unless the latter is within quite narrow limits. And even if these limits should be successfully extended there still remains the unbalancing problem which in some plants is at times very troublesome. Regulation seems to us to involve two quite distinct processes, each of them involving engineering and inventive skill of no mean order. First, the primary voltage at the receiving end of the line must be held as nearly uniform as the conditions of load permit; and, second, the residual variations, including the effects of unbalanced load, must be taken care of at the sub-station. With respect to the former, several methods have been proposed of compounding the generators so as to take care of the general conditions of drop. However well designed the generators may be they will not, without assistance, take care of the drop in the line, and while the compounding devices may be far from perfect they can at least keep the variations of voltage at the receiving end within reasonable limits—within, at least the capacity of the regulative appliances there installed. As for sub-station regulation, careful hand regulation is not to be held in contempt, and on some systems it proves entirely adequate.

But there is certainly a loud call for automatic regulators capable not only of holding the general voltage steady, but of correcting unbalancing, whether the primary voltage is steady or not. In theory, such automatic regulation should be fairly easy of accomplishment, for it merely means the automatic operation of sub-station regulators such as are even now available. But in practice we have yet to hear of such apparatus being successfully used, although from time to time attempts at its construction have been made. To produce the required results the regulation should be by rather fine degrees, and the regulators on the two or three phases of the distributing system should have range enough to cover easily the maximum variation of voltage as between phase and phase. We have knowledge of several experiments on such apparatus being in progress, but of actual commercial results there are as yet none on record. Of the demand for such automatic regulation there is no question, and it is safe to say that the first successful apparatus on the market will meet a reception very gratifying to the inventor. But he has not yet appeared to claim his reward and we desire kindly but vigorously here to stir him into a sense of his responsibilities. It is time for him to move on and to move quickly. There is need of results, for power transmission must not fail of good service.

The Convention of the National Electric Light Association.

Mr. C. O. Baker, Jr., master of transportation of the National Electric Light Association, writes us: "It was stated in the transportation notice sent out last week that extra cars would be attached to the 8.30 a. m. train of the New York Central & Hudson River Railroad on Sunday and Monday. This is an error, as the 8.30 a. m. train does not run on Sunday, neither will extra cars be attached to this train on Monday (Empire State Express); but necessary extra cars will be attached to all other trains."

Following is the programme of the meeting:

TUESDAY, MAY 21.

Morning Session, 10 O'Clock.—Address by President Cahoon. Paper, by C. R. Van Trump, Wilmington, Del., on "A Station Load Diagram."

Afternoon Session, 2 O'Clock.—Paper, by Francis W. Willcox, Harrison, N. J., on "The Practical Side of the Incandescent Lamp." Report of the Committee on Standard Candle-Power of Incandescent Lamps," Dr. Louis Bell, chairman. Report of the Committee on Amendments to Freight Classification of Electrical Apparatus, James I. Ayer, chairman.

WEDNESDAY, MAY 22.

Morning Session, 10 O'Clock.—Paper, by H. W. Hillman, Schenectady, N. Y., on "Arc Lighting at the Beginning of the Twentieth Century." Report of the Committee on Photometric Value of Arc Lamps, Henry L. Doherty, chairman.

Afternoon Session, 2.30 O'Clock.—Paper, by Louis R. Wallis, Woburn, Mass., on "The Foresee (4-C) System of Charging." Report of the Committee on Uniform Accounting, G. E. Tripp, chairman. Report of the Committee on Analysis of Flue Gases, Henry L. Doherty, chairman. Executive Session—Report of the Committee on Legislative Policy, Samuel Insull, chairman.

THURSDAY, MAY 23.

Morning Session, 10 O'Clock.—Paper, by Augustus Treadwell, Jr., New York, N. Y., on "Storage Batteries in Central Station Work." Report of the Committee on Rules for Electrical Construction and Operation, Captain William Brophy, chairman. Topic, "Steam Heating from Central Stations."

Afternoon Session, 2.30 O'Clock.—Paper, by Calvin W. Rice, New York, N. Y., on "Distribution of Current at High Potential in New York City." Report of the Committee on Amendments to By-Laws, Samuel Insull, chairman. Executive Session. Reports of the secretary and Treasurer and Executive Committee. Election of officers for ensuing year.

Following are the officers of the Association and the members of the Executive Committee:

Officers—President, James Blake Cahoon, New York, N. Y.; first vice-president, Louis A. Ferguson, Chicago, Ill.; second vice-president, W. Worth Bean, St. Joseph, Mich.; secretary and treasurer, George F. Porter; master of transportation, C. O. Baker, Jr. Executive Committee: Henry L. Doherty, Denver, Colo.; Charles B. Hunt, London, Ont.; Ernest H. Davis, Williamsport, Pa.; H. M. Atkinson, Atlanta, Ga.; Samuel Insull, Chicago, Ill.; Samuel Scovil, Cleveland, Ohio; Charles E. Scott, Bristol, Pa.; William M. Brock, Paterson, N. J.; E. F. Peck, Brooklyn, N. Y.

Summer Meeting of the American Institute of Electrical Engineers.

The Institute has announced the following programme subject to revision, and has sent copies to members of the various electrical engineer societies in Europe. It is proposed to begin by a meeting of the members of the American Institute of Electrical Engineers and their European guests for formal welcome and reception on Wednesday, Aug. 14, 1901, at the house of one of the engineering societies in New York City, as found most convenient and as arranged later. A collation will be served after the meeting, and there will be a steamboat excursion in the afternoon.

On the two following days technical visits will be made to important works and installations in New York city and vicinity. A banquet will take place on one of these evenings, and arrangements may be made later for a reception or some entertainment in the evening. No special assignment is made for Saturday, in order to enable visitors to make their own arrangements for sight-seeing and recreation.

The council committee has under consideration for Sunday, Aug. 18, a daylight trip up the Hudson to some convenient point, thence by rail to Albany, where the party will stop over night, leaving early on Monday, Aug. 19, for a visit to the works of the General Electric Company at Schenectady. From Schenectady the party will go by special train to Buffalo. On Tuesday morning, Aug. 20, the general meeting will open at Buffalo, in the Temple of Music, with addresses by the Exposition and municipal officials. A preliminary visit will be made to the Exposition in the afternoon. On the three following days there will be sessions for the reading and discussion of papers in the forenoon, and perhaps on some of the afternoons. The director-general of the Exposition has designated Thursday, Aug. 22, as "Electrical Day."

The programme contemplates the allotment of an entire day, if possible, for an excursion to Niagara Falls and the various electrical features to be seen at that place. Visits will also be made to various sub-stations in Buffalo from which Niagara power is distributed. The closing meeting will probably be held on Saturday, Aug. 24. Entertainments and receptions may be provided for some of the late afternoons or evenings.

Visitors desiring to include other large American cities in their tour, will be able to obtain all information desired from the secretary of the Institute, and also from members of the Institute residing in these cities who will be in attendance at the meeting both in New York and Buffalo.

Local committees of the American Institute of Electrical Engineers will be appointed in some of the larger cities to co-operate with the council committee for the purpose of facilitating the arrangements which the visitors may desire to make for visiting various places of interest.

The Consolidation of Lighting Interests in Cincinnati.

After a period of embittered warfare, in which a hot but fruitless campaign has been waged against electricity by some of the parties interested in gas, an important consolidation has been effected in Cincinnati, Ohio, through the intervention of the North American Company, of which Mr. C. W. Wetmore is president, and whose able representative has been Mr. John I. Beggs. The amount of the capital stock apportioned to the different companies on the recommendation of the arbitrators is as follows:

Cincinnati Gas Light & Coke Company..	$19,264,000
Cincinnati Edison Electric Company....	7,742,000
Jones Brothers Electric Company.....	896,000
First Cincinnati Edison Electric Illuminating Company.	84,000
Brush Electric Light Company.....	14,000
Total	$28,000,000

This amount is the capitalization of the new corporation, which takes the name of the Cincinnati Gas & Electric Company. The members of the new board of directors are: S. R. Burton, George Bullock, J. T. Carew, R. S. Cunningham, W. A. Goodman, A. Hickenlooper, R. A. Holden, A. H. Hinkle, M. E. Ingalls, N. G. Kenan, M. E. Moch, Casper H. Rowe, George R. Sheldon, J. G. Schmidlapp, C. W. Wetmore.

Of the new board of directors, nine are from the gas company interests, five from the Edison Company and one from the Jones Brothers Company. Beyond the fact that General Hickenlooper, president of the old gas company, will be elected president it is not positively known who the other officers of the company will be. It is intimated, however, that Mr. Wetmore will be made vice-president of the company, that being the same place that he has held in the organization of the Cincinnati Edison Electric Company. It is the idea of Mr. Wetmore that there can be a much larger business developed in the supply of electric current to manufacturing establishments, and the business in this direction will be actively pushed. As for the gas business, Mr. Wetmore believes that there is a great opportunity for the extension of the use of gas for fuel. These two branches of the business will afford opportunities for largely increasing the business of the combined company, in addition to the natural increase of the consumption of gas and the extension of the commercial electric lighting.

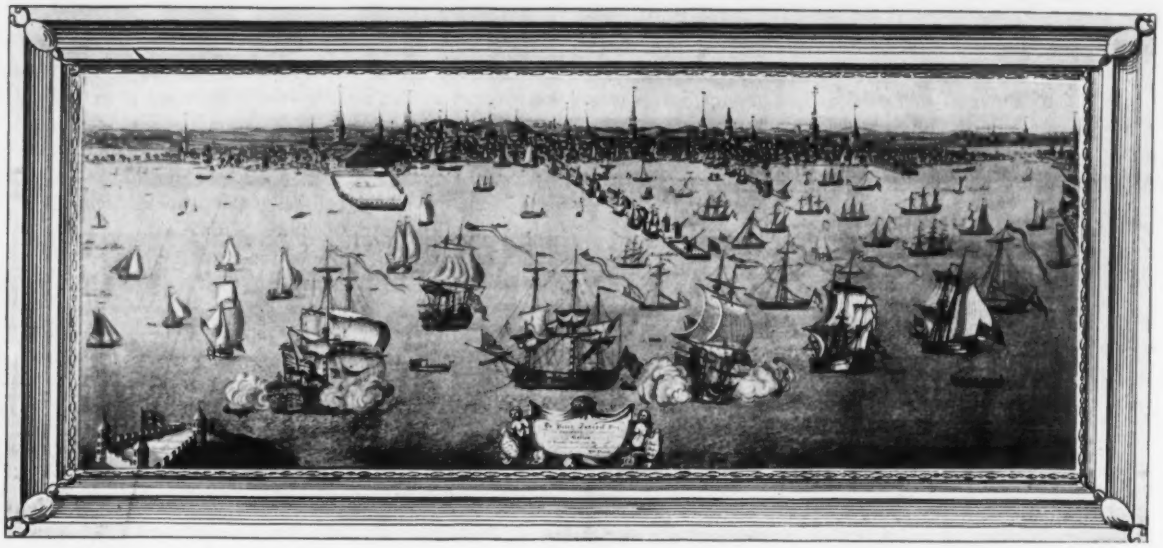


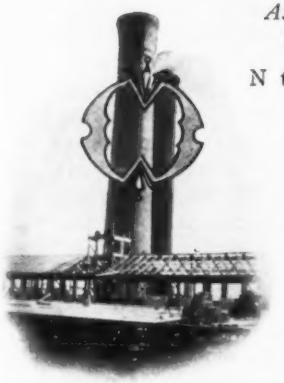
FIG. 1.—*View of Boston in 1773, Taken from Engraving Belonging to the Bostonian Society, Boston, Mass.*

The Edison System in Boston—Its Development and Present Status.

BY E. S. MANSFIELD.

INTRODUCTION.

"No, ne'er was mingled such a draught,
In palace, hall or arbor,
As freemen brewed and tyrants quaffed
That night in Boston Harbor."



N the 16th of December, 1773, the little town of Boston was in a state of unusual excitement. Lying anchored at Griffin's wharf were three ships, lately come from England, laden with tea consigned to certain Boston merchants by the East India Tea Company, upon which had been imposed a tax by the British Government. Tea being one of the most popular articles of import, the mother country had taken this method of forcing upon her liberty-loving daughter the policy of "taxation without representation," which was not only distasteful to the colonists but was opposed with all the vigor of their patriotic hearts.

Nineteen days had elapsed since the arrival of the first of these ships; days filled with anxious waiting combined with feverish activity. Every effort had been made to have the ships returned to England without discharging their cargoes, but without avail. The Governor was determined and the consignees were persistent.

By virtue of the law, if the tea was not discharged within 20 days after the arrival of the ships the custom-house officers would have the right to unload it themselves, and it was the solemn resolve of the committee that the tea never should be landed. A meeting was being held late in the afternoon at the Old South Church, where the patriot leaders were speaking in the strongest terms against the oppression of the crown and trying to effect some means of raising the embargo. During the discussion, the Quaker Rotch, owner of one of the ships, entered the meeting and announced that the Governor had absolutely refused to permit the withdrawal of the ships, whereupon Samuel Adams arose and, with a loud voice, exclaimed: "This meeting can do nothing more to save the country." This was the signal previously agreed upon, and a band of 40 or 50 of the citizens of Boston, who, by the flickering light of their candles, had decked themselves in the guise of Indians, passed by the door of the church, waving hatchets in their hands and giving voice to their warwhoops, and proceeded on their way, marching two by two down Milk Street, through Pearl till they reached Griffin's Wharf, where they posted guards to prevent the intrusion of spies, took possession of the three tea-ships, ripped open 340 chests and in about three hours threw into the Atlantic the whole consignment of tea, valued at about $100,000, and then dispersed in perfect order without molesting any other property.

If these same disguised citizens of Boston could pass along the same route to-day, before they had proceeded a great distance down Pearl Street, instead of the dwarfed masts of three tea-ships clustered about the quiet wharf, they would see the twin chimneys of the Edison Company's third district station rearing their graceful shafts 200 ft. into the air, surmounting a station of imposing proportions, equipped with apparatus the most modern and most progressive of any in the electric lighting industry. There they would find the boiler room directly over the spot where the tea-ships had

FIG. 2.—VIEW OF BOSTON ABOUT 1800, FROM AN ENGRAVING OF THE BOSTONIAN SOCIETY, BOSTON, MASS.

been anchored years before. They would also find that the huge stones and timbers which composed the old wharf had been removed and that this whole area, where the waters of the harbor had been wont to ebb and flow with untrammeled liberty, had been driven thickly with piles and filled in with cement. They would also find there a continuous demonstration of the fact that salt water is as efficient for condensing purposes as it is for steeping tea, and it would not be surprising if they also found one of the company's

agents on hand offering to replace their tallow candles with the Edison incandescent lamps in the ratio of 16 to 1, supplied from their underground mains.

The station referred to above is one of the most up-to-date plants in the country, and forms one of the six stations which comprise the manufacturing and electric storage equipment of the Edison Electric Illuminating Company of Boston, three of the stations being equipped exclusively with storage batteries and accessories, the other three containing the generating apparatus, to which is added in each case an electric storage battery plant.

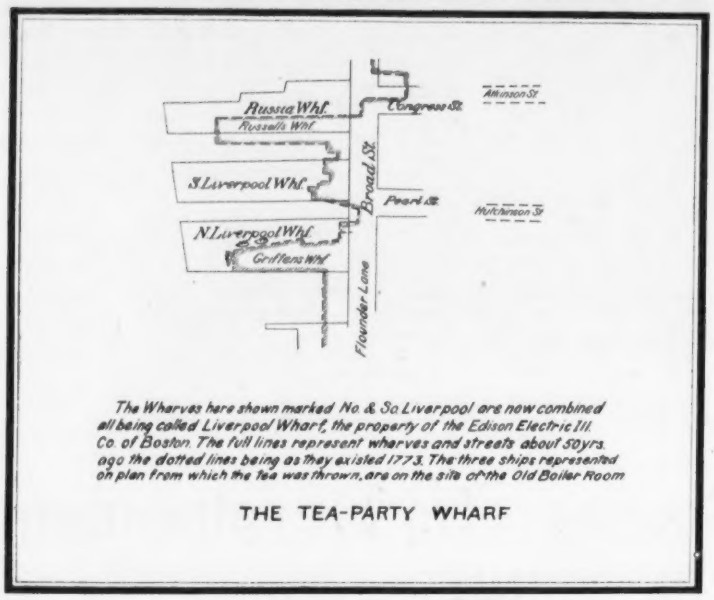

Russia Whf.
Russells Whf.
S. Liverpool Whf.
N. Liverpool Whf.
Griffens Whf.
Broad St.
Congress St.
Pearl St.
Allinson St.
Hutchinson St.
Flounder Lane
The Wharves here shown marked No. & So. Liverpool are now combined all being called Liverpool Wharf, the property of the Edison Electric Ill. Co. of Boston. The full lines represent wharves and streets about 50 yrs. ago the dotted lines being as they existed 1773. The three ships represented on plan from which the tea was thrown, are on the site of the Old Boiler Room
THE TEA-PARTY WHARF

FIG. 3.—THE TEA-PARTY WHARF.

It is our intention in this article to describe, as fully as may be, all the important features of the company, not only from the standpoints of generating and distribution, but also touching many of the local conditions which have influenced the development of the Edison system in Boston.

Space will be devoted to each of the stations in turn, giving more especial attention to the most recent plant on Atlantic Avenue, together with the addition thereto which has just been completed. This combined station is the one which occupies the site of the Tea Party Wharf, as described above.

Attention will also be called to a few of the more interesting details which pertain to the system, and which are instrumental in increasing its commercial efficiency.

HISTORICAL.

The Edison Electric Illuminating Company of Boston, was organized Dec. 26, 1885, with a capital stock of $100,000, which included the payment of $35,000 to the Edison Electric Light Company, the parent company, for license rights under the Edison patents. This contract limited the operations of the company to an area of about 70 acres in the business center of the city, almost directly surrounding what is now the first district station of the company. The right was given, however, to extend over the entire city of Boston or any part of it on equitable conditions. The plant which formed the nucleus of the new company consisted of one 200-hp Babcox & Wilcox boiler, and one 90-hp Armington & Sims engine, driving two Edison type H dynamos having a capacity of about 400 lights each, installed in the basement of Cashman & Keating's printing office situated in the rear of Haymarket Place, near Head Place. The company, having obtained a franchise from the city, leased a piece of property extending from Head Place to Bumstead Court, containing a two-story brick building, the lower floor of which had previously been used as a stable and the upper one as a tenement. The building was slightly changed over, and the company, having obtained possession of the little plant described above, removed it to the lower story of this building, which occupied a part of the land now covered by the "First" station boiler room. This station (Fig. 13) was started on Feb. 20, 1886, and the first customer to be supplied with electricity for lighting was the Bijou Theater, on the occasion of the production of "Iolanthe" on the evening of Feb. 22. The equipment of the station was soon after increased by the addition of one horizontal tubular boiler, one 125-hp Armington & Sims engine driving two Edison type H dynamos, which came from the New Orleans Exposition, and a similar engine and dynamos which had been sent from the Edison station at Rochester, N. Y. There was also a 30-hp Armington & Sims engine, to which were belted two Edison type S dynamos. This station gave the company a capacity of 2400 16-cp lamps burning at one time. In order to secure a full complement of customers at as early a date of possible, the company adopted the policy of free wiring for prospective customers and, in a very short time, the business had increased to so great an extent that the plant was taxed to its utmost capacity. It was only necessary to do free wiring for about six months, as the new method of illumination became so popular that customers were willing to have their premises wired at their own expense. In a very short time, the initial station proved itself so inadequate for the increasing business of the company, that at a meeting of the stockholders, held on the 10th day of November, 1886, it was voted to increase the capital stock to $250,000, and to enlarge the plant. Work was commenced at once on a new two-story brick building, 70 ft. by 50 ft., adjoining the old station, with an entrance on Head Place, having space for the accommodation of 20 150-hp Armington & Sims engines and 40 Edison bipolar dynamos of the No. 20 type, two dynamos being belted to each engine and run on the Edison three-wire system. There were installed at this time, however, seven engines and fourteen dynamos, the station being first operated in June, 1887.

FIG. 5.—NEW LINE OF WHARF.

FIG. 4.—TEA WHARF ROCKS.

This station in Boston was probably the first power station in the world, as previous to this time there is no record of more than one or two motors being operated from a single plant, while the Boston station, in the latter part of 1887, was supplying current for 92 motors with an aggregate of 300 horse-power. Later, motors were run on the outside wires of the three-wire system, this company being the first one to adopt this system of power transmission.

FIG. 6.—AT THE WHARF END.

In September, 1887, Mr. C. L. Edgar, who directly previous to this time had been engaged in designing and building small central stations in Pennsylvania, became the station manager of the new company, and from that time up to the present Mr. Edgar has been personally identified with the progress and enlargement of the company, and it may be said that the present prosperous condition in which the twentieth century finds it, is largely due to the wisdom and foresight of the one who now holds the combined office of president and general manager.

Notwithstanding the mammoth proportions of the new plant on Head Place, as seen in the light of the time, such a fully equipped station satisfied, only temporarily, the growing demands of the company, so that from time to time it was necessary to make additions or construct new stations as the case might be, and the business increased so rapidly that there was but a short interim between the successive additions.

In June, 1887, the capital was increased to $500,000, and a new district opened between Tremont and Washington Streets, as far north as Bowker Street.

The financial showing of the Boston plant, even while using old second-hand machinery, was so promising that it not only made it easy to secure this additional capital for the increase of the plant,

but it also resulted in securing the capital for the starting of the Chicago Edison Company, the Philadelphia Edison Company and the two uptown stations in New York City of the Edison Illuminating Company.

On Dec. 21, 1887, the second district station, fronting on Hawkins Street and extending through to Bowker Street, was started for the first time. This plant consisted of a two-story brick building, in which were installed two Heine boilers, one of 200-hp and the other of 300-hp capacity, four Armington & Sims 150-hp engines and eight Edison type No. 20 dynamos. This equipment was later increased to 12 engines and 24 dynamos. During the year, the overhead system of distribution was beginning to be abandoned and about 10 miles of three-wire underground tube was laid.

In June, 1888, a fire broke out in the first station dynamo room, destroying all the apparatus there contained. During the progress of the fire, a telegram was sent to Schenectady, requesting the immediate shipment of dynamos, and these, together with such ones as could be borrowed near home, were set up temporarily in the engine room, so that in 20 hours after the fire had been extinguished the current was again turned on.

During the summer of 1890 the first station building on Head Place was enlarged to include five stories, the first two being occupied by the generating plant and the other three being devoted to miscellaneous departments and the general offices of the company. The still increasing demand for current soon rendered the supply from these two stations, even when fully equipped, totally inade-

FIG. 7.—GENERAL PLAN OF THIRD STATION PROPERTY, ATLANTIC AVENUE—ORIGINAL INSTALLATION AND PROPOSED EXTENSIONS, 1891.

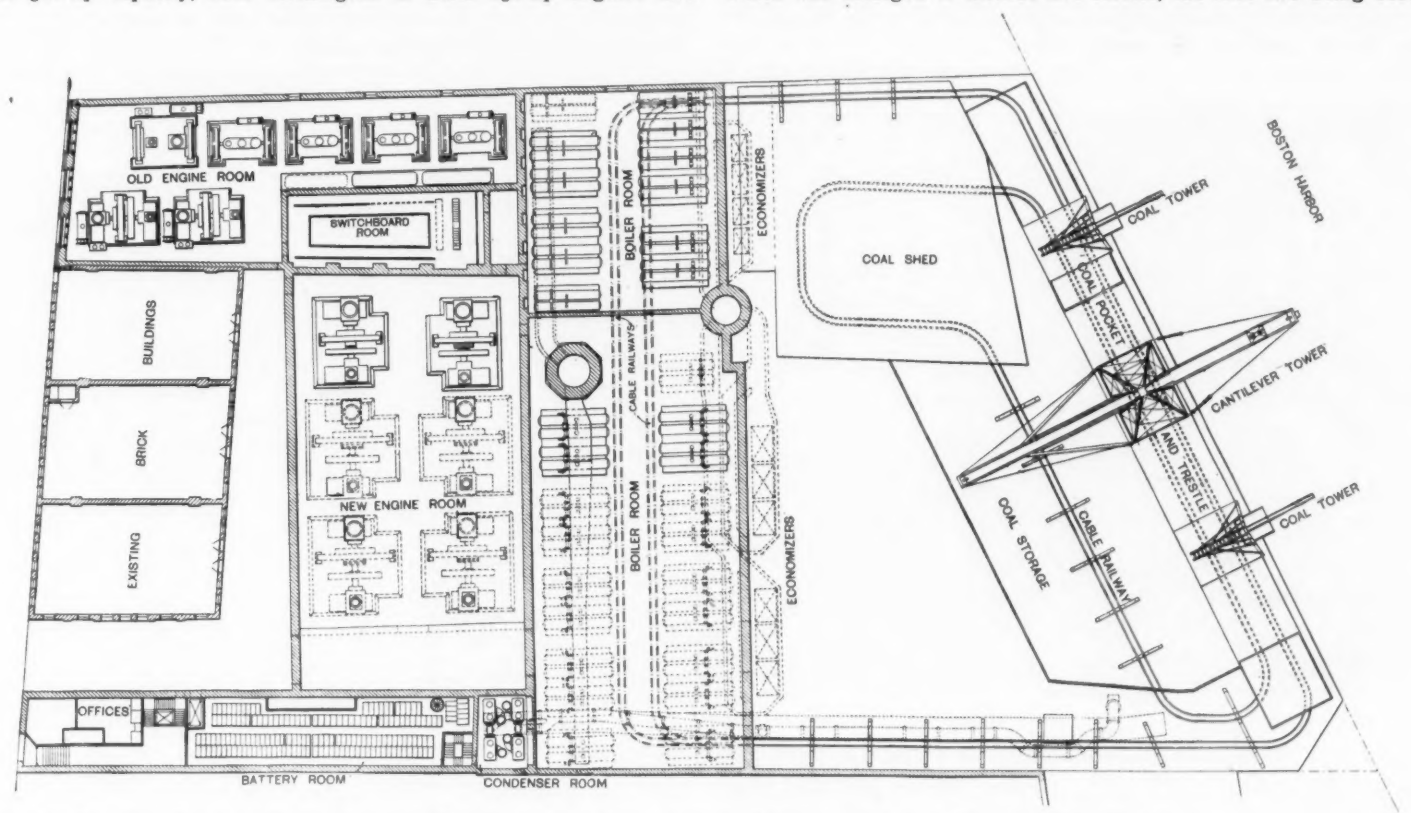


FIG. 8.—GENERAL PLAN OF THIRD STATION PROPERTY, ATLANTIC AVENUE—INSTALLATION AND PROPOSED EXTENSIONS, 1901.

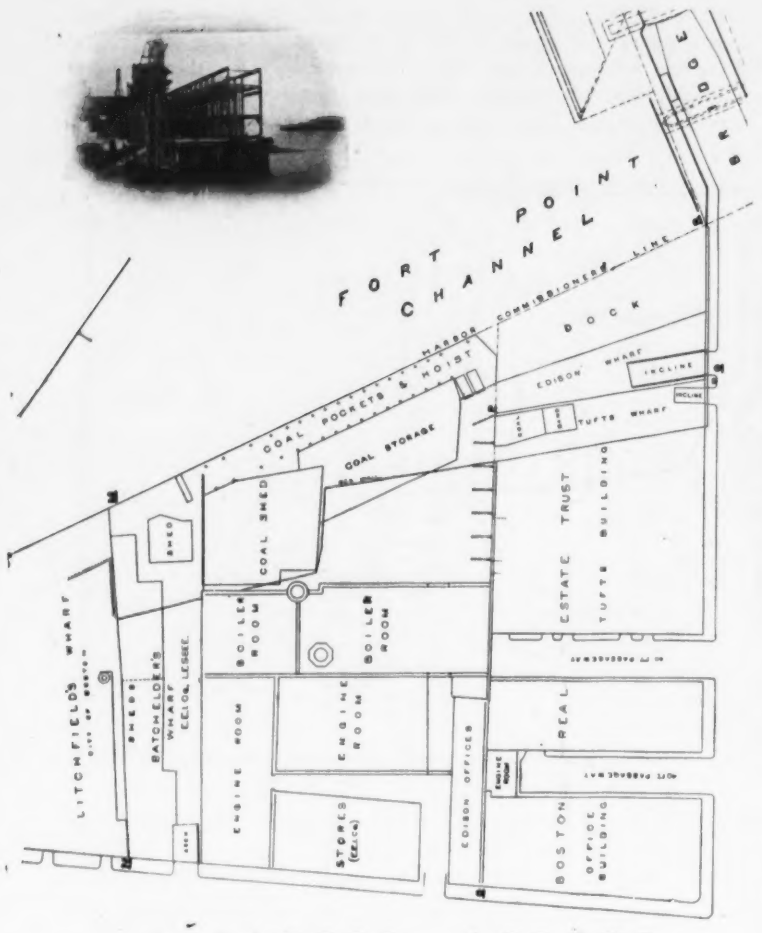


FIG. 9.—SURVEYOR'S PLAN OF ENTIRE ATLANTIC AVENUE PROPERTY.

quate and made necessary the building of a larger station composed of larger units and working on a more economical basis. This condition of affairs was met and its problem solved by the foresight of the company in providng such a station previous to the time when it was actually needed. To this end, Mr. Edgar visited many of the most important stations in Europe during the spring of 1890, investigating thoroughly the subjects of the construction of station buildings, types and sizes of units employed, and the general conditions which go to make up a modern economical electric light station. The outcome of this investigation was the company's third district station, now situated on Atlantic Avenue, at the foot of Pearl Street, occupying what was formerly known as Dolbeare's and Liverpool wharves, and a part of which was the site of the old "Tea Party Wharf," this property having been purchased by the company for this purpose. The ground was broken on Oct. 10, 1891, and a modern fire-proof structure erected, consisting of an engine room separated from the boiler room by a thick brick wall. The equipment consisted of Babcock & Wilcox water-tube boilers and triple expansion, vertical, condensing engines, to which were coupled direct-driven generators. This station was looked upon as a very great departure in the electric lighting industry, as these slow speed vertical engines were the first ever built on this side of the water, and the direct connected units were among the first in the history of the business, while the size of the engine room, with its ideal location upon the water front and its modern facilities for handling and storing coal, created widespread interest among engineers throughout the country.

Mr. Edgar went again to Europe early in 1893 to investigate the subject of storage batteries as auxiliaries to large central stations, such use having been made of them to quite an extent abroad, although practically a new thing in this country. The use of the storage battery in this capacity recommended itself so strongly that one was contracted for, to be installed on trial at the third district station on Atlantic Avenue, and this was put into commission in March, 1894, having been installed in a brick building just outside of the station and directly back of the switchboard. This battery was the first of its kind in the country and was looked upon with many misgivings by eminent engineers in different branches of the industry; but the battery proved itself equal to the test and showed itself to be a very important adjunct to the system. In June, 1895, another German battery was purchased and installed at the Head Place station in a building on Bumstead Court. The use of these batteries proving so satisfactory in connection with the generating plant, at the stations then existing, it was decided to provide battery sub-stations in the outlying districts, in order to increase the capacity of the system and to reduce the feeder losses during maximum distribution.

The fourth district station, consisting of a battery plant, was installed in August, 1896, and was located on Scotia Street, quite near to the center of the Back Bay district.

In September, 1897, a storage battery was installed in the second station on Hawkins Street, a third story being added to the building to accommodate it, and in August, 1898, a storage battery was put into commission in the fifth district station on West Canton Street. In September, 1900, another battery was installed in the sixth district station, situated on Pittsburgh Street, in South Boston, thus covering a district which heretofore had been supplied by means of a submarine cable across the Channel.

In March, 1900, work was started on an addition to the Atlantic Avenue station, following very closely the plans proposed in 1891, and consisting of a steel frame brick structure, comprising an engine and boiler room, connecting and extending at right angles to the station already existing. The wharf was also extended out to the Harbor Commissioners' line and modern coal handling machinery installed. This addition to the latest station has so increased the capacity of the system that a natural growth of the company's business can be handled without additional building for some time to come.

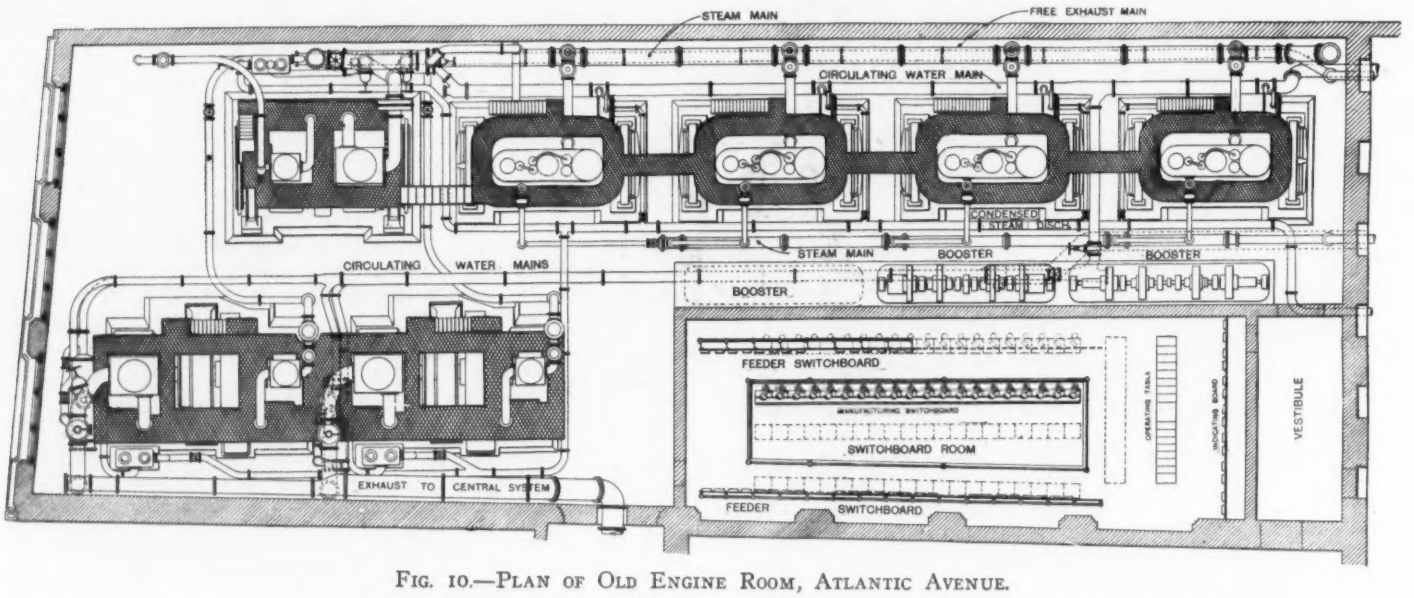


FIG. 10.—PLAN OF OLD ENGINE ROOM, ATLANTIC AVENUE.

STATION NO. 1.

Situated on Head Place, near the corner of Boylston and Tremont Streets, and extending back to Bumstead Court, is the first district station of the company. The main building has a frontage of 70 ft. on Head Place, extending 50 ft. to the rear. It is five stories high, and is of fireproof construction throughout, not only the walls being made of brick but also the ceilings and partitions. The only exposed woodwork in the building is found on the floors used as offices and appears in the form of doors and window casings, and in some cases light wooden partitions. The ceilings throughout the building are made up of brick arches supported between 10-inch wrought iron I-beams, spaced about 5 ft. apart, resting on pairs of 10-inch I-beams bolted together, which are in turn supported by cast-iron columns 11 inches in diameter on first and seconds floors, and 7 inches in diameter on the remaining floors. The walls to a height of 3 ft. are painted a dark red color; the remaining area of the walls and the ceilings are finished in pure white. The fifth floor of the building is tiled throughout in a very artistic manner, different designs being used in the various offices and hall. The other floors are covered with a layer of concrete 3 inches thick, upon which is laid about an inch of asphalt. The engine room floor is made up partially of movable cast iron plates, below which run the exhaust steam pipes, as do also the drips from the engines. The third and fourth floors are painted a deep maroon color. The building is lighted by means of windows on Head Place, also by large skylights. Where daylight cannot be obtained, illumination is provided by Jandus arc lamps, supplied with current from the incandescent mains.

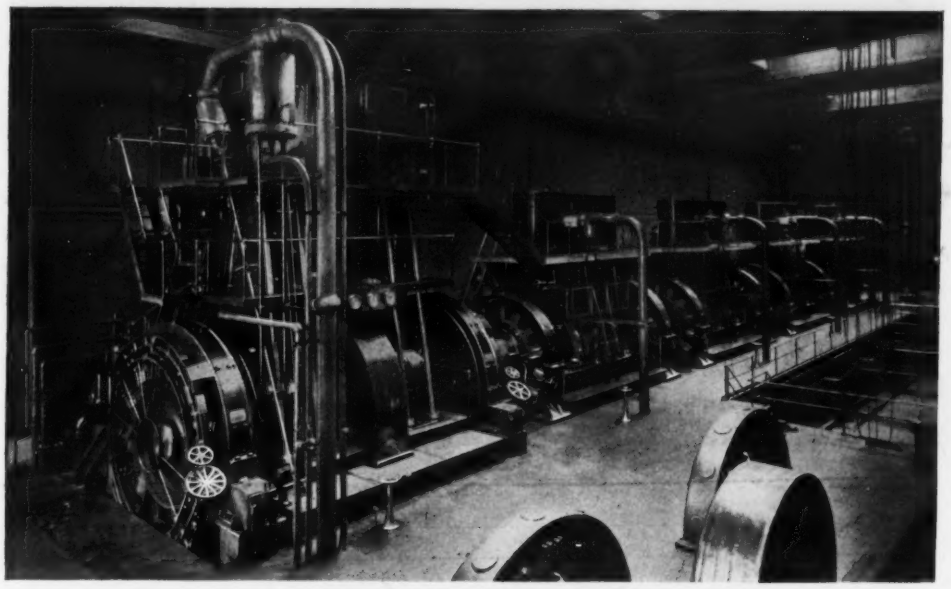


FIG. 11.—OLD GENERATING ROOM.

The engine room occupies the first floor, just below the street level and is equipped with 19 Armington & Sims simple non-condensing engines of 150 horse-power, each running at a speed of 260 r. p. m. The cylinder diameter is 15½ inches, and the stroke 15 inches. The engines extend in rows along the width of the engine room, with the main operating valves of one row facing those of the next in order to facilitate economical handling. Also located on the engine room floor is a Knowles pump, directly driven by a 20-hp Edison, 250-volt motor, which operates a hydraulic passenger elevator. The engines transmit power to the dynamos in the next story by means of belts passing through the floor of the dynamo room. The generators, 38 in number, were built by the Edison General Electric Company, are shunt wound and of the bipolar type, with a rated capacity of 60 kilowatts each. To each engine are belted two of these 125-volt generators, running in series and furnishing current to the Edison three-wire system at a pressure on the outside wires of 250 volts maximum, so that each engine may be said to have connected to it and to control one three-wire unit.

Above the dynamos are suspended from the ceiling sets of copper rods, running the length of the room, to which are connected, through central station switchboards, the positive and negative sides of each dynamo, the neutral side of each dynamo being connected through a switch and Bergmann ammeter to the neutral bus-bar. Beneath each ammeter is a controlling rheostat connected in series with the field of the dynamo supplying current through that meter. The sets of copper rods referred to above conduct the current at the different voltages to the bus-bars located in the regulating and distributing room from which it is distributed at the voltage required through the feeder switches to their respective feeders.

In the regulating and distributing room (Figs. 15 and 16) is located a three-wire booster set, rated at 75 kilowatts, having four poles on each end and running at a speed of 750 r. p. m. The motor ends are wound for 250 volts and 300 amperes, while the booster ends have a capacity of 1350 amperes at 55 volts. Here also is situated the feeder switchboard in two parallel sections between which are the bus-bars. The positive and negative sides of the feeders are each connected through an ammeter to a four-way switch, so arranged that the feeder can be supplied with current from a bus of whatever voltage required. By means of a pressure wheel the pressure at the distant end of each feeder can be determined. Located on the east side of the room are the battery switches, operated by electric motors, by means of which one or more cells of the battery can be cut in or out as required. The feeder vault (Fig. 18) just below the regulating room consists of the feeder ends, extending into the room. The feeders are connected to the various feeder switches by copper bars so clustered that the positives and negatives are in groups by themselves and separated from each other.

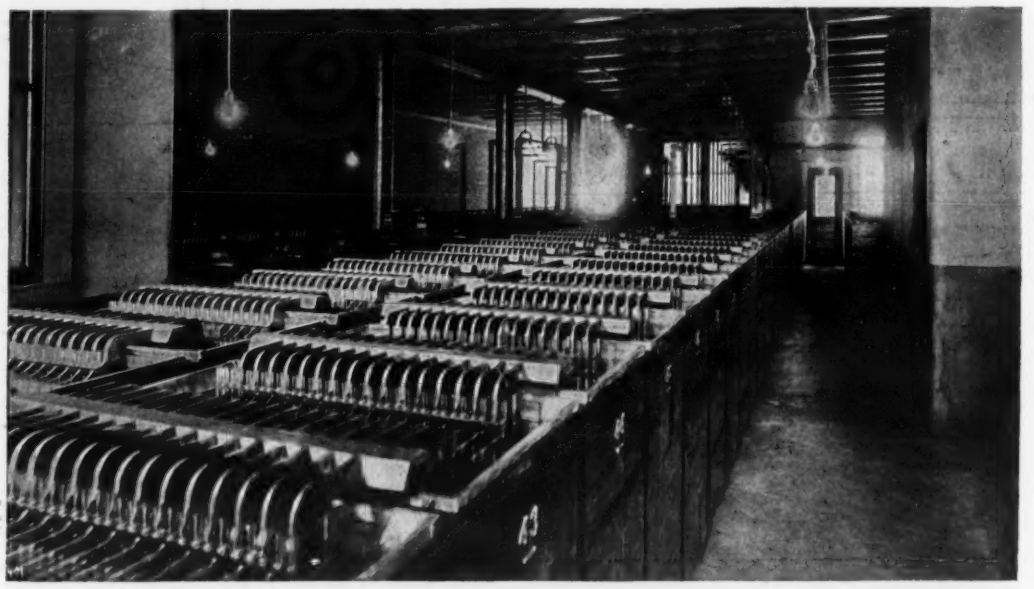


FIG. 12.—OLD STORAGE BATTERY PLANT.

The third floor of the building is occupied by the offices of the purchasing agent, the mechanical engineer and the general agents, while the fourth floor is given up to the accounting department, the offices of the auditor and cashier. The executive offices occupy the whole of the fifth floor, one suite being devoted to the use of the president and general manager, the other to the general superintendent.

The boiler room consists of a four-story brick building, 60 ft. by 35 ft., situated on Bumstead Court, just at the rear of and adjoin-

ing the engine room. The boilers at this station are operated at 100 lbs. steam pressure, there being installed on the first floor three Whittier return tubular boilers, each having a shell 16 ft. long and 72 inches in diameter, containing 140 3-inch tubes. The furnaces have each 36 square feet of grate surface. The second floor is used as an ash room, the ashes being discharged through chutes from the

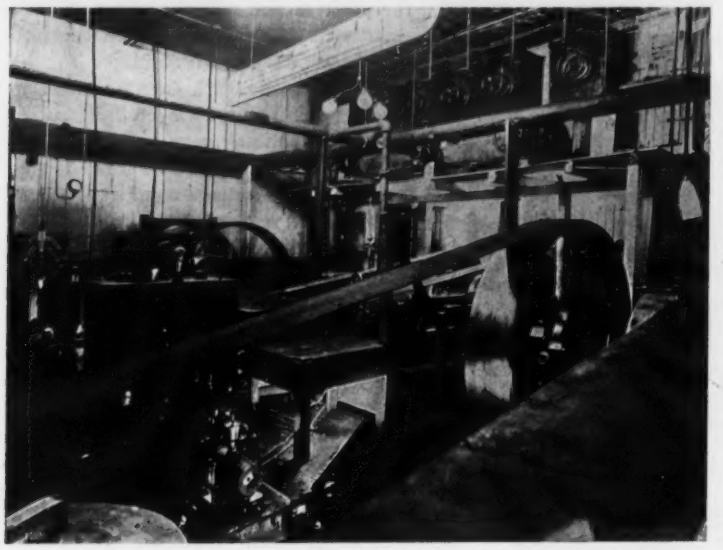


FIG. 13.—FIRST ENGINE AND DYNAMO ROOM OF THE COMPANY LOCATED IN AN OLD STABLE, BUMSTEAD COURT.

boilers above, after which they are teamed away. The third floor is equipped with five Babcock & Wilcox water tube boilers, having a nominal capacity of 285 horse-power each, made up of three 36-inch drums, having 15 sections of 12 tubes each, and a grate surface of 56 square feet. Facilities for producing forced draught on the Babcock & Wilcox boilers are provided by means of a 6-ft. B. F. Sturtevant fan driven by a double simple direct-connected engine running at 430 r. p. m. The boilers are supplied with city water by means of three Davidson simple feed pumps, having a 12-inch stroke, the diameter of the steam cylinder of one being 9 inches, of the other two 10 inches each. These feed-water pumps are fitted so that they can be used in connection with a system of piping and fire hose in case of fire. There are also provided in case of need three No. 9 E. Korting universal injectors. Before reaching the pumps the feed water from the city mains passes through a Goubert heater, which consists of a coil of pipe containing the water surrounded by exhaust steam from the engines. By this means the water is raised to a temperature of about 210 degs. F.

The fourth floor of the building consists of a coal bunker, having a capacity of 250 tons. The coal is hauled from the water front to a coal pocket beneath Bumstead Court, where it is deposited through coal holes. Beneath this pocket is a track for the accommodation of coal cars. These are filled from the pocket, raised to the roof by means of an electric elevator, and the coal is deposited into the bunker through scuttles from which place it is delivered, as required, in front of the boilers by means of steel chutes. The flue gases pass through a rectangular shaped chimney 150 ft. high, having sides 25 ft. by 14 ft. at the base and 22 ft. by 12 ft. at the top. The chimney has a brick cap surrounded by a grated iron platform and railing. Owing to its size and height, it is a landmark in this section of the city.

There are two storage batteries in use in connection with the station, which will be described together with the other batteries.

STATION NO. 2.

Almost a duplicate of the first station in matter of consruction and equipment, the second station (Fig. 17) was constructed to supply the demands of the business section of Boston north of that taken care of by the Head Place station. It has a frontage of 38 ft. 3 inches on Hawkins Street, extending through to Bowker Street, a distance of 164 ft., having a frontage of 15 ft. 3 inches on Bowker Street. The main building is three stories high, built entirely of brick and iron, and is very similar to the first station in respect to the interior finish. The ceilings, made up of brick arches faced with corrugated iron, are supported at the walls by 6-inch square iron columns and in the center of the engine room by a row of wrought iron columns 14 inches in diameter, and in the dynamo room by columns having a diameter of 11 inches. In the engine room are installed 12 Armington & Sims, 150-hp simple non-condensing engines, driving, on the floor above, 24 60-kw, 125-volt generators, built by the Edison General Electric Company, and connected in the same manner as the units at the Head Place station. The dynamo room is plastered and both this and the engine room are painted dark red to a height of 5 ft., the rest being finished in white. These rooms are lighted by windows on Hawkins Street and by Jandus arc lamps. The feeder switchboard is located in the western end of the dynamo room, through which the current from the different buses is distributed to the feeders in the vault below by means of flexible cables. On the south side of the room is located a General Electric three-wire booster set, consisting of a motor and booster for both positive and negative sides of the system. These boosters have each six poles, are rated at 75 kilowatts, and run at a speed of 650 r. p. m. The motor end runs on 240 volts, and the booster end is wound to deliver 1364 amperes at 55 volts.

On the third floor of the building is an electric storage battery which will be described later.

The boiler room is a continuation of the engine room, and is situated directly in the rear of it, consisting of one story with a coal bunker just above, the roof of which is on a level with the floor of the battery room. The boilers are operated at 100 lbs. steam pressure and consist of the following: Two Babcock & Wilcox single-deck water-tube boilers of 225 nominal horse-power, with Jarvis setting, which are made up of 13 sections of 9 tubes, each 18 ft. long by 4

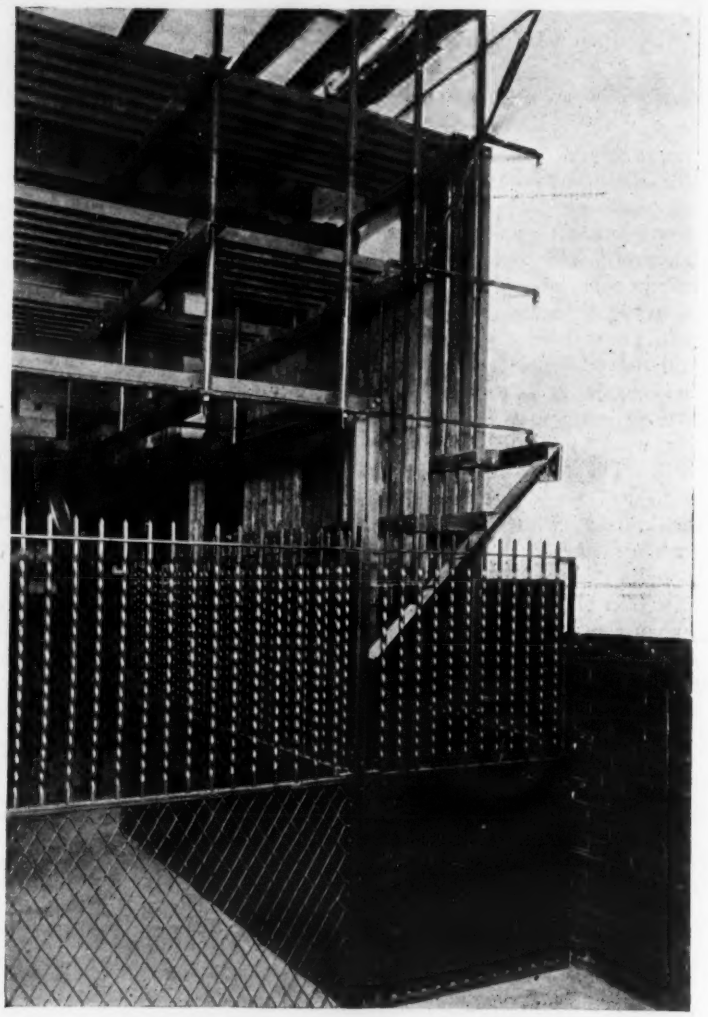


FIG. 14.—EIGHT COPPER BARS CONNECTING SWITCHES AND FEEDERS. FIRST DISTRICT STATION, BUMSTEAD COURT.

inches in diameter; two Heine safety boilers of 260 nominal horse-power each, having Jarvis setting, and consisting of 140 3-inch tubes with two 36-inch drums; one Heine safety boiler of 164 nominal horse-power, having 87 3-inch tubes and one 48-inch drum. The feed-water is supplied from the city mains and flows through a National heater by which it is raised to a temperature of about 210 degs. F. It is then delivered to the boilers by two simple direct-acting Davidson feed-water pumps, having 7-inch steam cylinders,

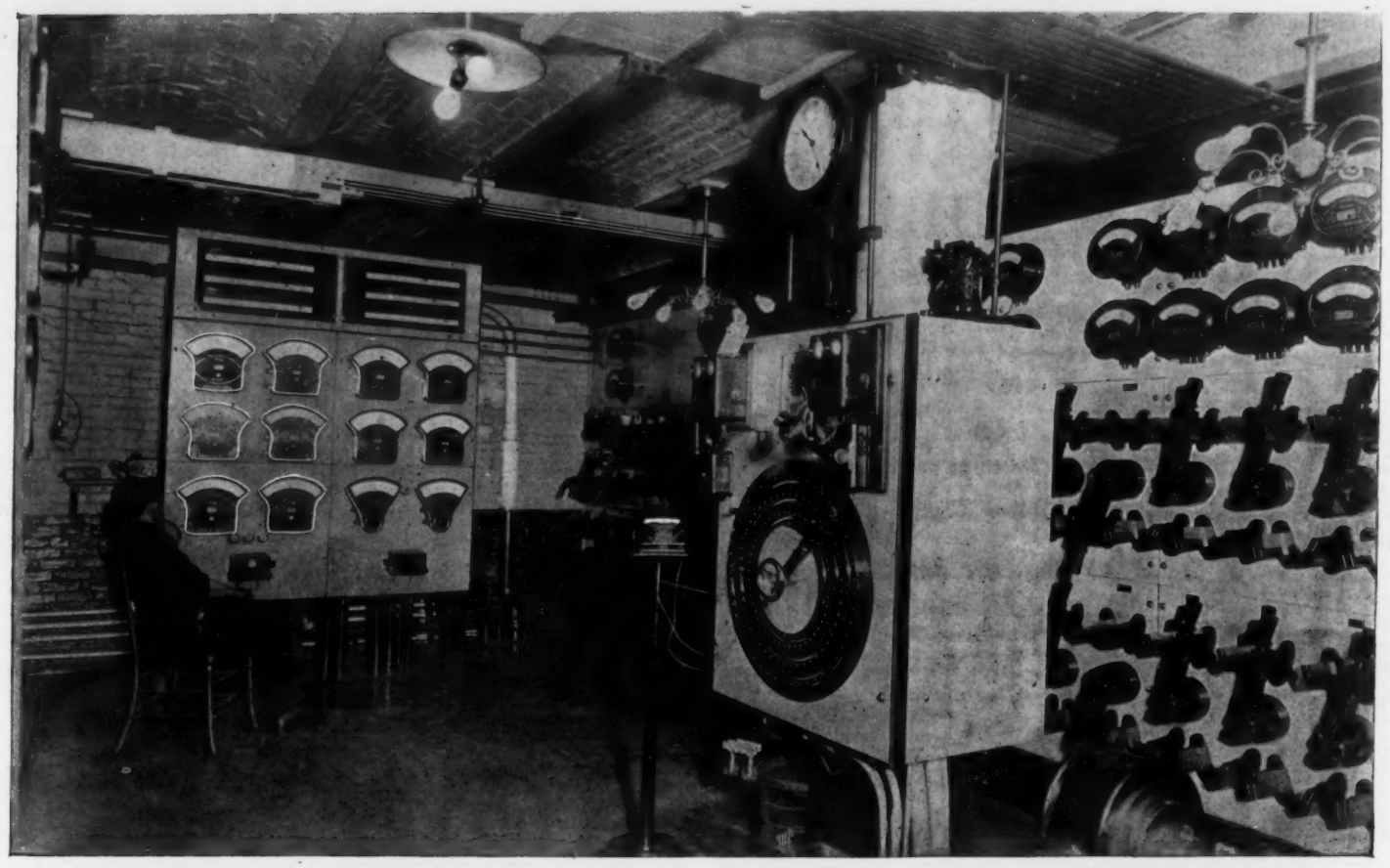


Fig. 15.—Regulating Room, Head Place Station—Feeder Switchboard and Pressure-Wire Wheel.

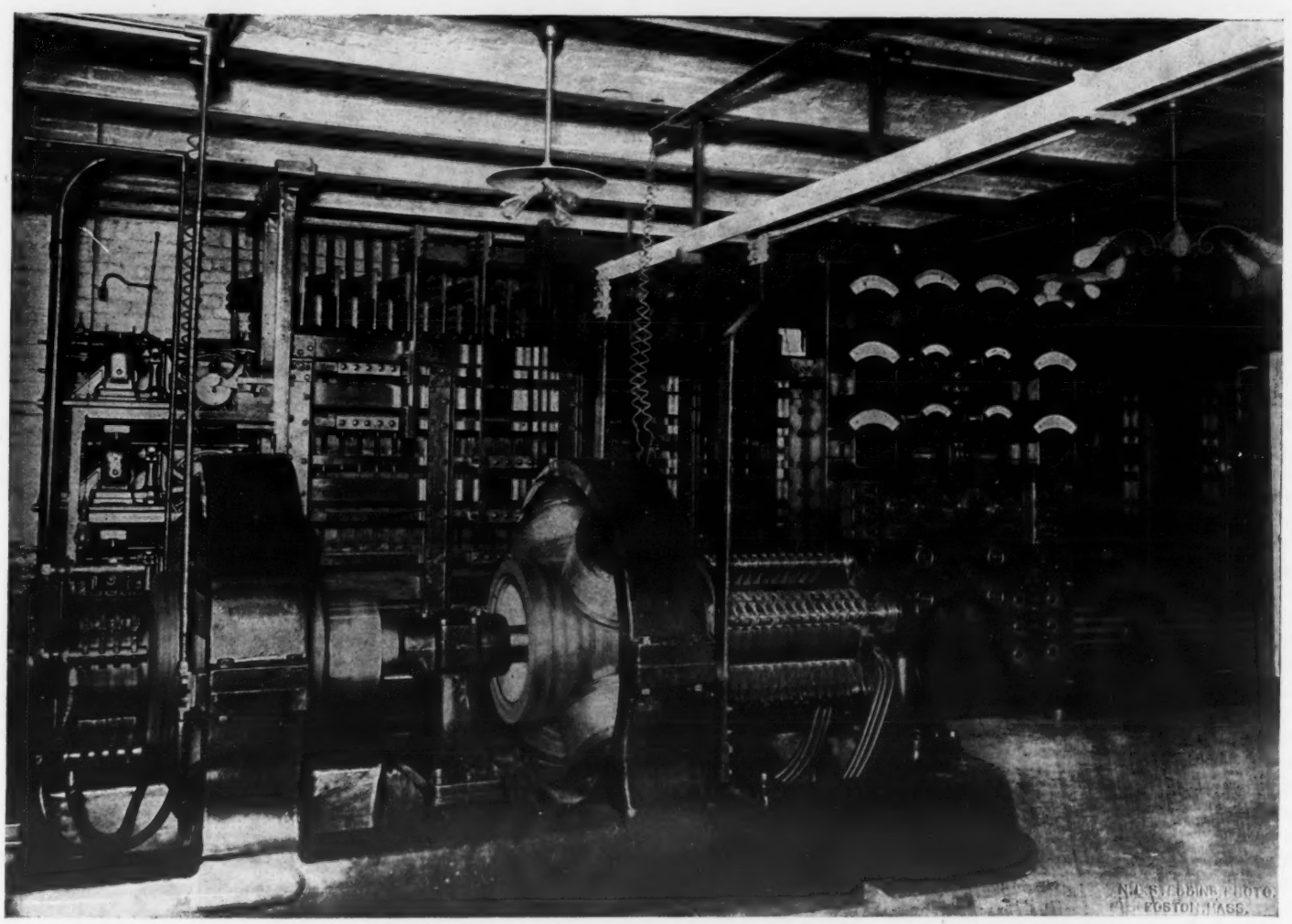


Fig. 16.—Regulating Room, Head Place Station, Showing Booster Set and Battery Regulating Switches.

with a stroke of 10 inches, and a water cylinder 4 inches in diameter. These pumps are also fitted to provide water for use in case of fire. Injectors are installed and always ready for use in case of necessity. Forced draught may be used on all the boilers by means of a Sturte-

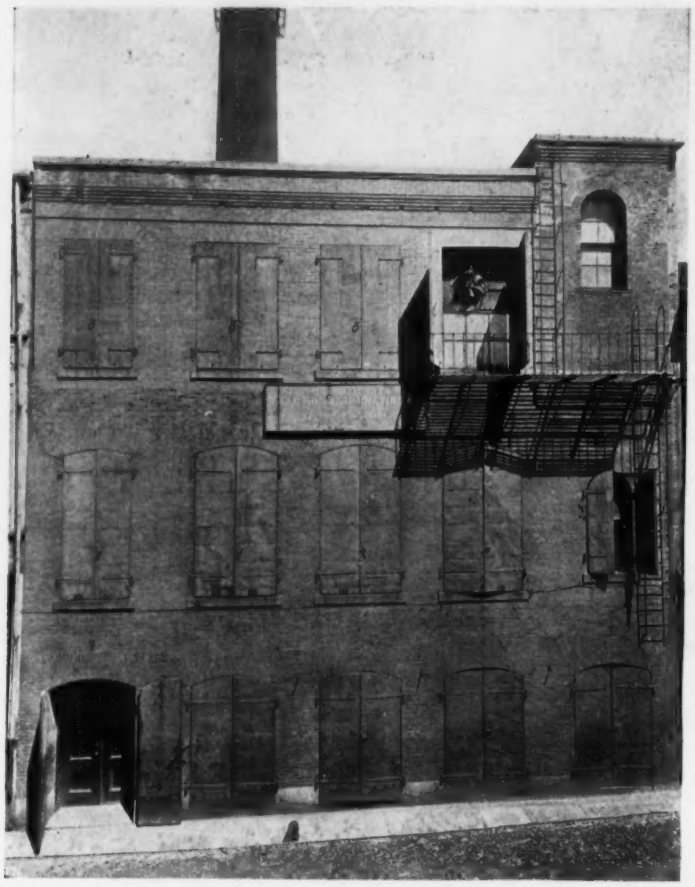


FIG. 17.—FRONT VIEW OF SECOND DISTRICT STATION, HAWKINS STREET.

vant blower, having a fan 5 ft. in diameter, driven by a 25-hp, 220-volt Sprague motor.

The coal is hauled to the station and discharged into a pocket beneath the sidewalk on Hawkins Street, from which place it is loaded into cars raised to the roof by an electric elevator and deposited through scuttles into the coal bunker of 200 tons capacity, located directly over the boiler room. The coal is delivered, as required, directly in front of the boilers, through steel chutes. The ashes are wheeled out into an ash room between the boiler room and Bowker Street and carted away.

STORAGE BATTERIES.

The electric storage battery, as a means of storing electrical energy and delivering it again, when required, at a per cent of efficiency great enough to make it of commercial value, has made very rapid progress during the last few years. Although having been used to some extent abroad, previous to 1894 the storage battery as an adjunct to large central stations was a thing almost wholly unknown in this country, and was even then just entering the experimental stage.

Having the courage of its convictions, the Boston Edison Company contracted for a battery plant which was first operated at the Atlantic Avenue station in March, 1894, being the largest one of its kind in the country. Soon after, the company installed other batteries, not only in connection with existing generating plants but as exclusive battery installation in districts widely removed from the central stations. For some time it had been necessary to refuse to supply power and light to new customers in outlying districts on account of the distance to the central stations which would be responsible for a heavy feeder loss and a wide variation in pressure. Neither would it be practicable to establish generating plants in these sections, not only on account of the character of the districts covered but also on account of the poor economy of such stations. The storage battery has, to a certain extent, met and solved this problem and has opened up territory otherwise inaccessible to a system using direct current, exclusively, so that this system of storing and distributing electrical energy, although not by any means perfect, still fills a very important place in the economy of a modern central station.

The battery system of the Edison Electric Illuminating Company of Boston comprises eight storage batteries, located at the different stations, two of these being Tudor batteries made by the Accumulatoren-Fabrik Aktiengesellschaft, of Hagen, Westphalia, Germany, the other six being chloride batteries, manufactured by the Electric Storage Battery Company, of Philadelphia, Pa. A single cell of the Tudor battery consists of a tank of hard pine, 14 inches by 17 inches and 35 inches deep, lined with sheet lead 1-16 inch thick, containing 18 positive plates 5/8 inch thick and 19 negative plates 3/8 inch thick, each being 28 inches deep by 15 inches wide. Both the positive and negative plates are made of solid cast lead, with corrugated faces, which hold the active material, consisting in the positive of red lead oxide and of litharge in the negative plates. The plates are separated from one another by two rows of 5/8-inch glass tubes, extending the length of the plates. The plates are suspended by lead lugs on either side, which rest on two 3/8-inch glass plates extending to the bottom of the cell, the battery plates extending 5 inches from the bottom and 2 inches from the top of the cell. The electrolyte consists of distilled water, to which is added, in the ratio of one to four, sulphuric acid having a specific gravity of about 1.830. The cell furnished by the Electric Storage Battery Company, of Philadelphia, is its type H 47, of similar construction, which consists of an ash tank 46 5/8 inches by 21½ inches by 42 7/8 inches high, outside measurement, lined with 5-lb. lead. Each cell contains 23 positive and 24 negative plates 16½ inches by 33 inches.

FIG. 18.—CABLES CONNECTING SWITCHBOARD AND FEEDERS, SECOND DISTRICT STATION.

The negative plates of the cell are constructed of chloride of lead buttons with a frame cast around them, while the positive plates consist of cast lead grids with corrugated ribbon buttons pressed into them. The electrolyte is the same as described above. The cells are connected in series by means of heavy lead bars between the cells, to which the lugs of the positive plates of one cell

and the lugs of the negative plates of the next cell are firmly welded. They are connected to the regulating switches by drawn copper bars, varying in width from two to three inches and in thickness from ⅜ to ¾ of an inch. There are two batteries located at the Head Place station, one being a Tudor battery installed in a four-story brick

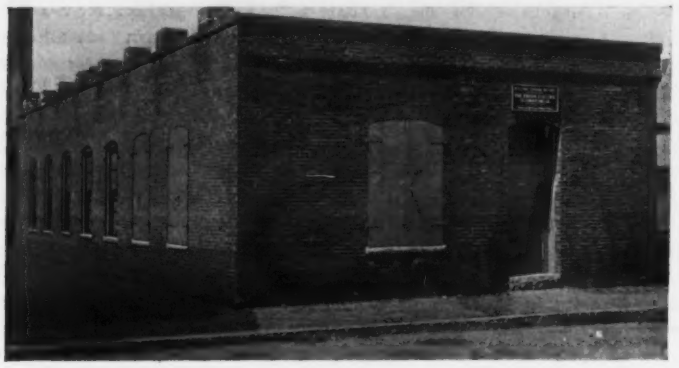


FIG. 19.—SIXTH DISTRICT BATTERY STATION, PITTSBURG STREET.

building on Bumstead Court just opposite the boiler room, the other one being an Electric Storage Battery Company product, located on the second and third floors of a new building at Nos. 1 and 2 Head Place, just adjoining the station building. The Tudor battery, located in the three upper floors of the building, consists of 144 cells as before described, 72 on each side of the system, 25 of which are end cells, each one being connected to a block in the regulating switch by means of a copper bar running into the regulating room on the first floor. The regulating switch consists of a line of insulated copper blocks, each one connected to an end cell, alongside of which runs a copper bar connected with the battery bus. Each end of a copper brush rests upon one of these strips and is mounted upon a threaded shaft which slides it along these strips, cutting in or out the cells as is desired. There are three of these switches in multiple on each side of the system, which are operated by an electric motor governed by a small switch on the regulating board, so that from 48 to 72 cells may be run in series on each side of the system and may be discharged at three different pressures, as may be required. The rate of discharge on both sides is 9400 amperes at a one-hour rate and 4890 amperes per hour for three hours, the voltage at the end of discharge being 1.7 per cell, which figure is uniform in all the batteries. The maximum charging rate is 3774 amperes. The specific gravity

FIG. 20.—FOURTH BATTERY STATION, SCOTIA STREET.

of the electrolyte is 1.888. The other first station battery consists of 75 cells of the chloride battery on each side, 25 of which are end cells, situated on the second and third floors of the new building on Head Place. The maximum charging rate is 2252 amperes, while the rate of discharge is 5600 amperes at 130 volts at a one-hour rate, and 2800 amperes per hour for three hours. The specific gravity of the electrolyte is 1.200 in all the American batteries. At one end of each of the battery rooms is partitioned off a regulating room, containing three regulating switches in multiple, the positive switches being in one room, the negative in the other. These switches are operated by means of an electric motor on each switch, which are controlled by push buttons on the switchboard in the regulating room. By means of a system of bevel gears and rods, an illuminated indicator in the regulating room shows how many cells are in circuit at any given time.

At the second district station on Hawkins Street, the battery room occupies the third floor of the building and contains 140 Electric Storage Battery Company's cells, 70 on each side of the system, the usual number being connected as end cells. The regulating switches, three in number, are located in a room at one end of the batteries and are erected in a vertical position with the threaded rods extending through the floor into the regulating room and terminating in a handwheel, so that the switches can be operated by hand by a man at the feeder switchboard. The maximum charging rate is 1600 amperes and the maximum rate of discharge is 4000 amperes at a one-hour rate and 2000 amperes per hour for three hours.

The storage batteries at the third station, two in number, are located in the basement and first floor of the company's system of dis-

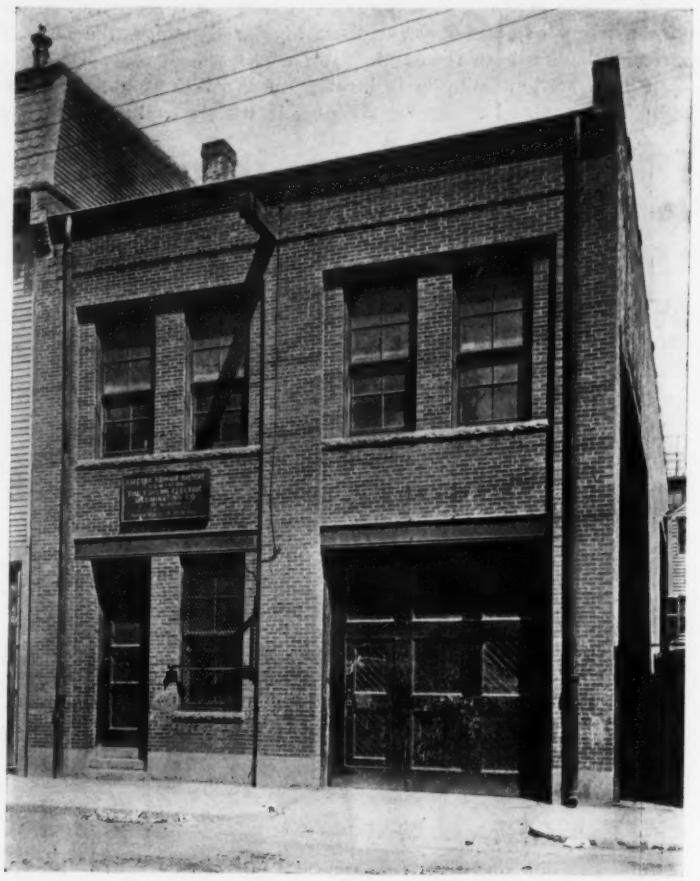


FIG. 21.—FRONT VIEW, FIFTH DISTRICT RATTERY STATION, WEST CANTON STREET.

tribution building, No. 516 Atlantic Avenue, just adjoining the new station. The two batteries are identical in all respects and each consists of 75 cells of the Electric Storage Battery Company's manufacture on each side of the system. The maximum charging rate is 2252 amperes and the maximum rate of discharge is 5600 amperes per hour for three hours. The regulating switches are installed in a small regulating room on the first floor, partitioned off from the battery room and consist of 12 switches, three in multiple, on each side of each battery. These switches are operated by electric motors through a set of gears and are controlled in the regulating room of the station at a distance of 200 ft. by means of push buttons on the switchboard. The main current to and from the batteries flows along underground cables connected to the battery bus-bars on the third-station switchboard.

The fourth station on Scotia Street supplies the district known as the Back Bay, and was not only the first exclusive battery plant erected by the company, but the first one in existence. The building is a one-story brick structure, covering an area of 60 by 65 ft. The roof is 25 ft. above the floor, and the walls are so constructed that

the room may be divided into two stories or may be enlarged by extending upwards. The front of the building is separated from the battery room by a plaster partition, forming a regulating room 12 ft. wide and extending the length of the building. The battery consists of 72 cells on each side, and in all other respects is exactly like the two batteries at Atlantic Avenue, described above, having been made by the same company. The copper bars from the end cells pass through the partition to the regulating room, where they are connected to three switches in multiple on both sides of the system, so that the batteries can be discharged at three pressures at the same time. These switches are operated by hand. Between the two regulating switches is a slate-regulating board upon which are mounted Weston portable voltmeters, reading to three volts, so arranged as to read, through circular cell switches, the voltages of the regulating cells on each side of the system. There are also on this board two Weston round pattern galvanometers and two booster field regulators. Opposite the regulating switches is the feeder switchboard which has two buses on each side of the system, and to the apparatus and feeders are connected two double-throw switches, thus permitting of the connection of any of them to either bus. Weston round-pattern ammeters are used to indicate the load carried by each feeder. There is also installed at this station one three-wire booster set, consisting of four 60-kw Edison bipolar dynamos, the booster armatures having been rewound.

The fifth station building is located on West Canton Street, between Tremont and Shawmut Avenue, is wholly of brick, 27 ft. 2 inches by 99 ft. 3 inches inside, and consists of two stories, one floor being below the street level. In this basement are located 144 cells of the Tudor battery, 72 cells on each side of the system, 25 of which are end cells. The maximum charging rate is 1986 amperes, and the rate of discharge is 4925 amperes at one-hour rate and 2570 amperes for three hours. There is also on this floor a booster set consisting of four Edison bipolar dynamos, the armatures having been rewound. There is in addition a feeder switchboard having 4 buses, 3-battery regulating switches in multiple, and meters, instruments, etc., similar to those installed at the Scotia Street station.

The sixth district station is the one most lately installed and is located on Pittsburgh Street, in South Boston, a short distance beyond the Congress Street Bridge. The station consists of a small one-story brick building, 27 ft. by 68 ft. by 12 ft. high, having a wooden roof. There is a partition which forms a regulating room in the front end and leaves the remainder for a battery room. The battery consists of 140 cells of the type manufactured by the Electric Storage Battery Company, of Philadelphia, having 70 cells on a side and 25-end cells. The maximum charging rate is 1280 amperes and the maximum rate of discharge is 3040 amperes at one-hour rate and 1520 amperes per hour for three hours. The regulating room, 20 ft. by 27 ft., contains two regulating switches operated by hand, in multiple on each side of the system, also feeder switches, boosters and measuring instruments similar to those at the other battery stations. All of the batteries on the Edison system taken together form one of the largest installations on record, which is capable of supplying a total of 43,765 amperes for one hour or 65,647 ampere-hours at a three-hour rate.

STATION NO. 3.

In 1891, without any precedent in this country, and with comparatively little in Europe in the way of ideal examples, the Edison Company of Boston laid out plans for a central station to be located on Atlantic Avenue, which would supply the growing demands of the company for a quarter of a century to come.

The plans included not only the ground property upon which buildings were to be erected, but the extending of the wharf into the channel to facilitate the handling and storage of coal; the character and extent of the structures, and the equipmnt of the station after its erection. It is worthy of note that plans as projected in 1891 have been carried out in 1901, almost in their entirety, after the vast experiences of a decade second to none in the history of electrical and mechanical engineering.

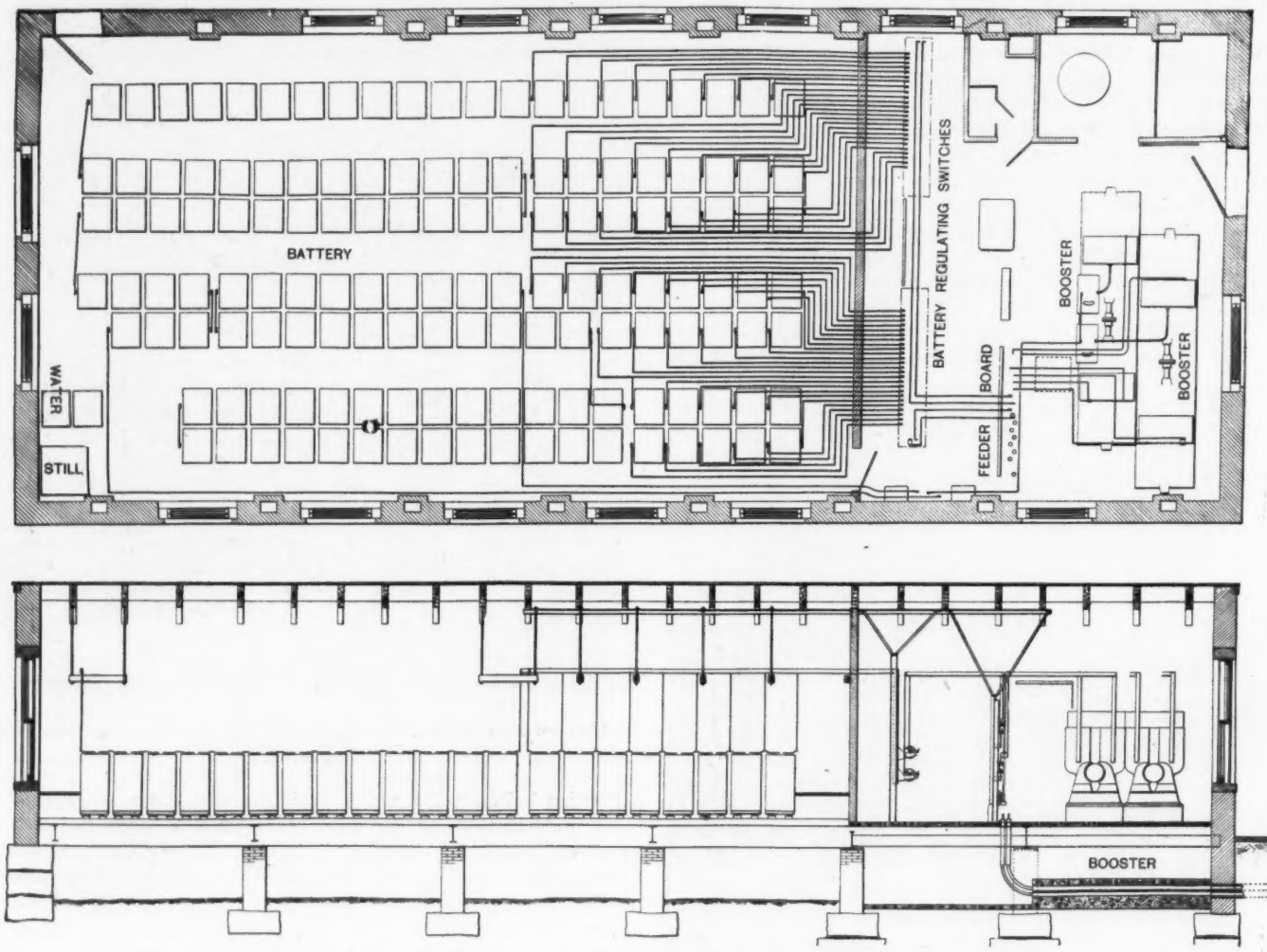


FIG. 22.—PLAN AND ELEVATION OF PITTSBURG STREET STORAGE BATTERY STATION.

On another page are included two plans (Figs. 7 and 8), the first one of which shows in full lines, the property and equipment of the company as it existed in 1891, with the proposed additions shown in dotted lines; and, second, a similar plan showing in full the total

installations in 1901, and having in dotted lines the proposed additions for the future. It will be seen at a glance that the only radical divergence between the two is the extension of the wharf to coincide with the Harbor Commissioners' line and the increase in size of the units in the station.

The property on Atlantic Avenue controlled by the Edison Company, as shown on the surveyor's plan, is included in the area lettered M-N-O-P-Q-R, and consists of Liverpool and Dolbeare's wharves, upon which the station stands, and Batchelder's wharf just north of the station building and the new driveway wharf, extending from the Edison property to Congress Street, the last two being leased by the company. The total property covers about 129,500 sq. ft., extends 299 ft. on Atlantic Avenue and 305 ft. back to the Harbor Commissioners' line on the north side and 480 ft. on the south side, giving a water frontage of 559 ft. As a matter of convenience in the description of this property, the old station building with its foundation built in 1891, and the addition thereto made in 1900, will be treated separately, more space being given to the latter construction, while the apparatus and equipment will be described as a whole, regardless of location.

The old station is situated on Atlantic Avenue, having a frontage of 60 ft. and a depth of 230 ft. The engine room, 60 ft. by 160 ft., is separated from the boiler room by a thick brick wall, through which the steam mains pass on their way to the engines. The height of the engine room is 40 ft. above the engine room floor, this being 10 ft. above the base of the engine foundations, while the boiler room roof is 49 ft. above the ash room floor.

The entire building above the foundation is of brick, the walls being plain but substantial; the façade on Atlantic Avenue, however, is of artistic design, being built of Perth Amboy yellow brick, with terra cotta trimmings. Three large arches extend across the front of the building, surmounting massive glass windows which serve to flood the front of the engine room with light. The roof is supported by nine iron girders, 3 ft. 9 inches deep and 60 ft. span, built by the Smith-Carleton Iron Works, of Boston. The roof is covered with tar and gravel, and is broken up by four skylight ventilators, running transverely, which occupy about one-quarter of the roof area.

In the southeasterly corner of the engine room there is partitioned off a switchboard room, 70 ft. by 26 ft., which extends 14 ft. above the engine room roof, and is surmounted by a monitor. The switchboard room will be described later. The boiler room is 62 ft. high in the center and 60 ft. on the sides, above the ash room floor, and has a large monitor through which are two tracks of the cable railway upon which the coal cars run. Winslow & Wetherell, of Boston, were the architects of the old building, and Whidden & Co., of Boston, were the contractors.

As the solid ground beneath this station only extended about 88 ft. from the front wall a large part of the building rests upon an artificial foundation. Under the engine room were driven on 4-ft. centres, spruce piles, not less than 7 inches in diameter at the smaller end, and varying from 25 to 35 ft. in length. The foundation of the walls consists of granite 6 ft. high, under which are piles 2 ft. on centres.

The boiler room is supported by eight piers of solid masonry, each one resting on 30 piles, 35 ft. long, driven to a solid bearing and cut off at one foot below mean low water. At the rear of the boiler room is a heavy masonry sea wall, resting on seven rows of piles on 2-ft. centres.

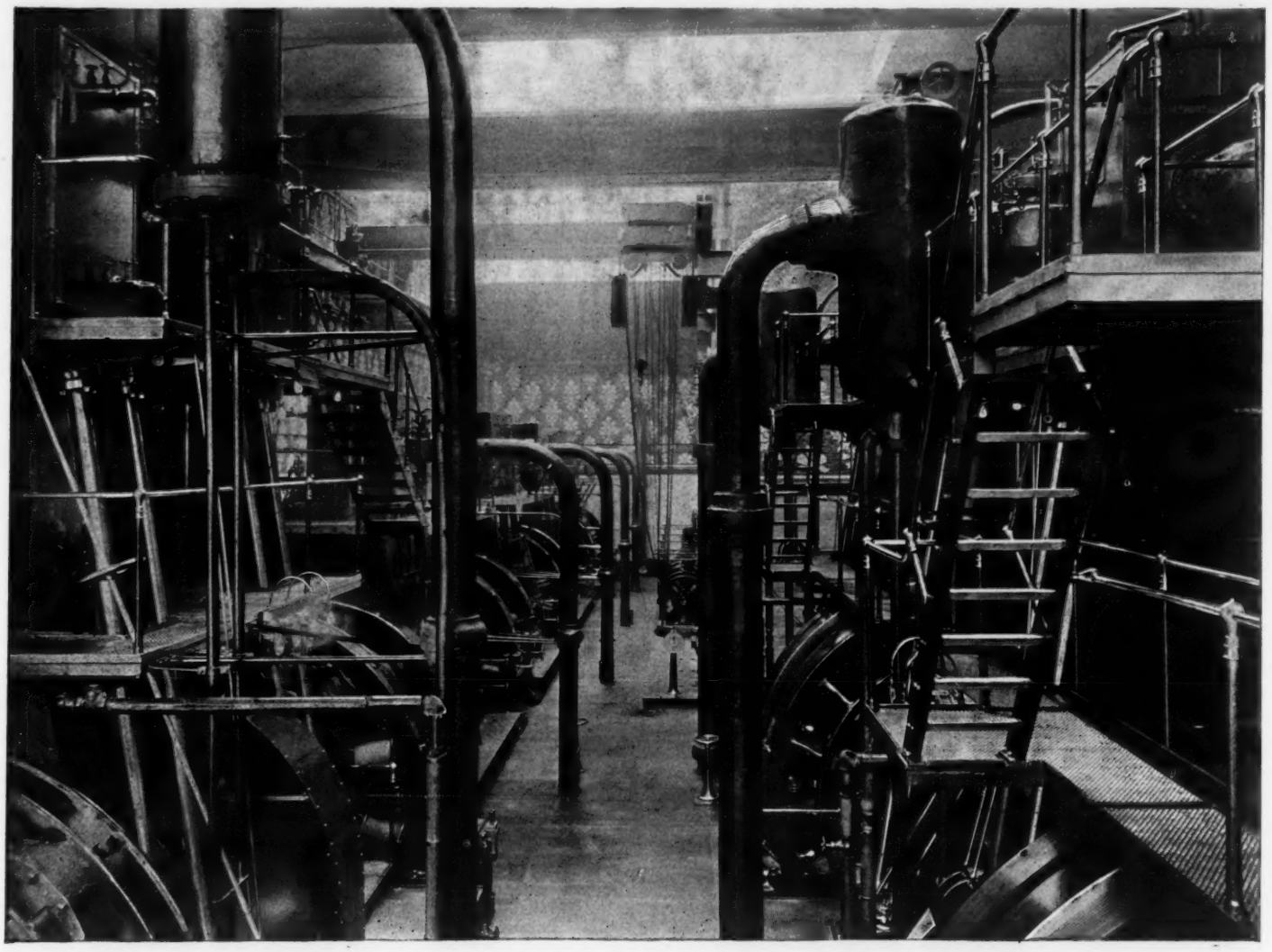


FIG. 23.—VIEW IN THE OLD ENGINE ROOM, ATLANTIC AVENUE, LOOKING EAST.

In the engine room the piles were cut off 7 ft. above mean low water and covered with 6 ft. of solid concrete, made up of one part Portland cement, two parts of sand and four parts of broken stone. Running on rails near the roof of the building are two cranes operated by hand chains, one of 15-ton capacity, having a span of 56 ft., located in the west end of the room, the other of 16-ton capacity and 32-ft. span, running the length of the switchboard room.

NEW CONSTRUCTION.

The new construction work at the Atlantic Avenue Station, begun

in March, 1900, consisted of an engine room, extending at right angles from the old engine room to the system building, a distance of 150 ft.; a continuation of the old boiler room, a distance of about 160 ft., to an extension of the westerly wall of the system building;

FIG. 24.—VIEW ALONG THE OLD BOILER ROOM, ATLANTIC AVENUE.

and an extension of the wharf property to the Harbor Commissioners' line.

FOUNDATION.

The excavation for the foundation of the engine and boiler rooms presented difficulties rarely met in this class of engineering and rendered the work exceedingly slow and tedious. The whole area was first excavated to a depth of 6 ft., the material removed consisting of ashes, oyster shells and other filling. As soon as the required depth was reached, Nova Scotia spruce piles 50 ft. long, with tips 6 inches and butts 14 inches in diameter, were driven 2 ft. on centres each way.

After the section was piled for a short distance towards the water front, obstructions were found which caused the piles to broom repeatedly. In one or two cases where the piles were capped, the tips turned and came up again four or five feet away, and one pile, as afterwards appeared, came in contact with one of the oak timbers forming part of an old wharf and was driven completely through it, leaving a hole the size of the iron tip.

Upon digging down farther to remove obstructions, there was found a part of the old "tea party" wharf, consisting of wooden cribs loaded down with huge stones, the wharf proper having been built up from these. There was also found the old sea-wall which formerly had protected the wharf, and which now presented the greatest obstacle to the work of driving piles. This sea wall, which had to be removed as far as possible, was about 150 ft. long, averaged 10 ft. in width, and extended down from 22 ft. to 28 ft. It contained stones of great size, one being 16 ft. long, 7 ft. wide and 20 inches thick.

While the sea wall was being removed near the old station, the walls of the building had to be held in place by six 2½-inch rods passing through from side to side, being bolted on the outside. The wall towards the excavation was also reinforced by four 12-inch timber shores. When the excavation had reached below low water, the greatest difficulty commenced, for in spite of the fact that the trenches were dammed with sand bags, and one 10-inch and two 8-inch pumps were working continually pumping out the water, the work could only be carried on at low tide. Although this was continued from 15 ft. to 20 ft. below low water, yet towards the end of the wharf the stones were so far below the surface that it was not possible to remove them. Some of the oak timbers, 14 inches square, belonging to the old wharf, were found in perfect condition.

There were driven in all 5280 piles, 1000 of which were shod with iron shoes, and it took three pile drivers five months, working night and day, to do the work. After the piles were all driven, the ground was excavated 3 ft. more and the piles were cut off at grade 7. Under the new chimney 400 piles were driven in a space 35 ft. x 40 ft., these being cut off at grade 2.

On top of the piles, over the entire area, was laid concrete to a dept of 3 ft., except in the northeast corner of the boiler room, where the old sea wall was found. As it was impossible to remove the lower part of this, the hole was filled up with 26 ft. of concrete on top of the sea wall. Six feet below the top and imbedded in this concrete were placed four 15-inch 60-pound I beams 20 ft. long, and twelve 12-inch 40-pound I beams 12 ft. long, across which rested fifteen 12-inch 40-pound I beams 16 ft. long.

There was then added concrete to the depth of 6 ft., making a total depth of 9 ft. over the entire surface except as in places noted. The concrete below the chimney was 14 ft. deep. The composition of this concrete was one part Alpha (Portland) cement, three parts sand and five parts 2-inch broken stone. The engine foundations are built of brick, laid in Alpha Portland cement. Each engine bed is fastened to its foundation by four 3-inch bolts and thirty-six 1½-inch bolts, 2 ft. long, embedded in the foundation.

During the excavating and piling, provision was made for a sluiceway to be used for the purpose of supplying salt water to the condensers. It is 245 ft. long and extends from the condenser room under the boiler room and wharf out into the harbor; the lower part being 8 ft. below low water thus guaranteeing an adequate supply of water at all times. This sluiceway was built of two thicknesses of 6-inch hard pine sheet piling driven tight, treenailed with oak; the outside course being 26 ft. long and the inside 15 ft. long. The

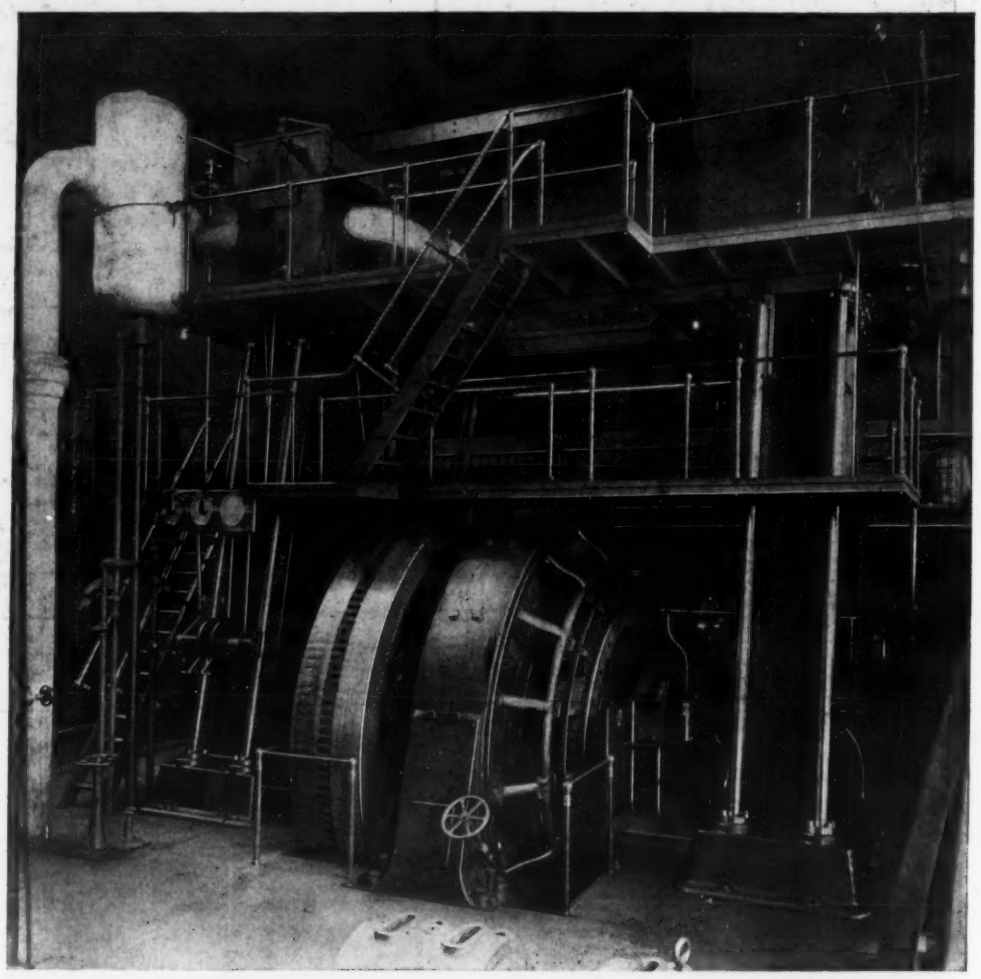


FIG. 25.—1200-HP MCINTOSH & SEYMOUR ENGINE AND 800-KW GENERATOR, OLD STATION. ATLANTIC AVENUE.

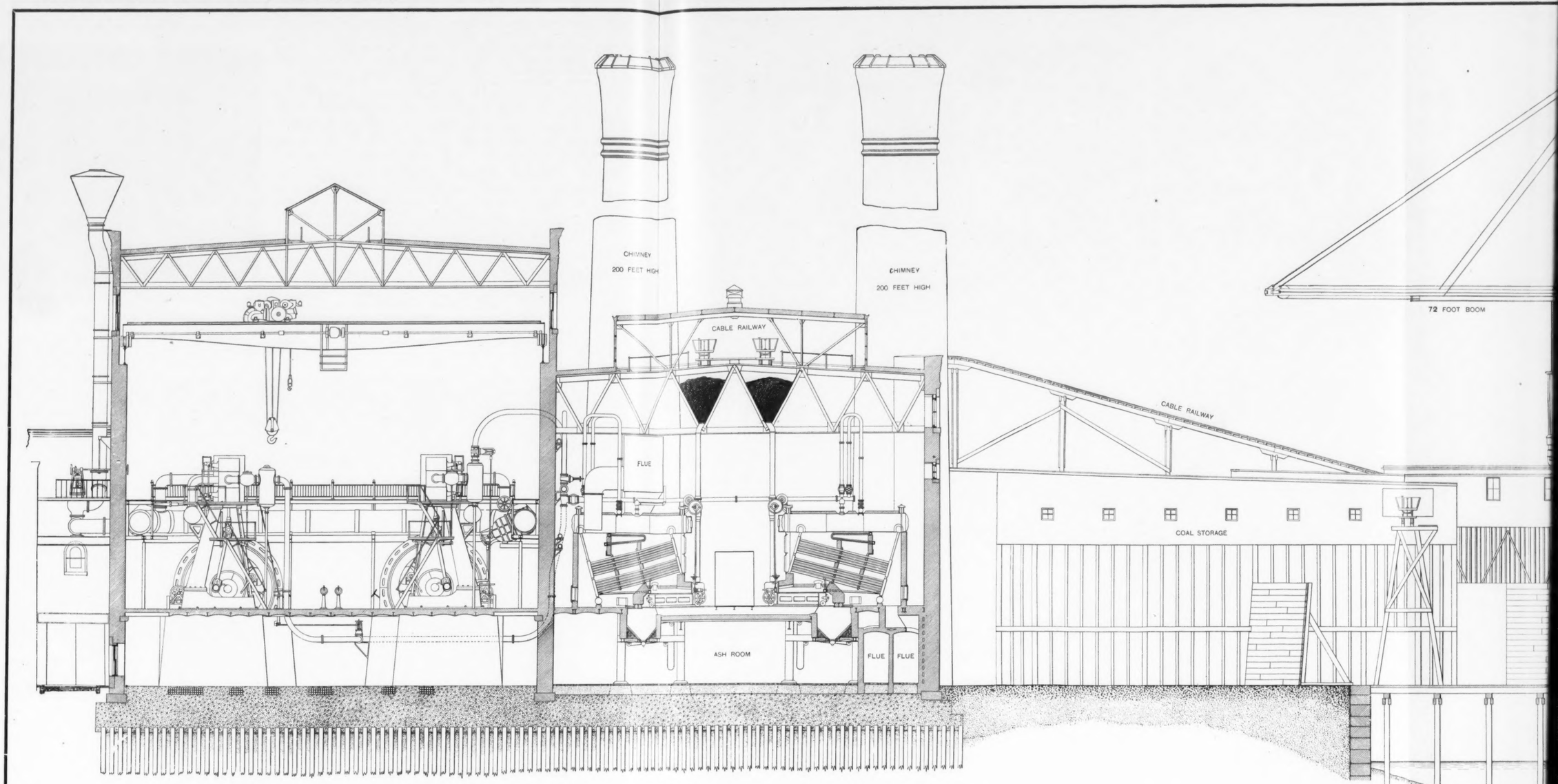
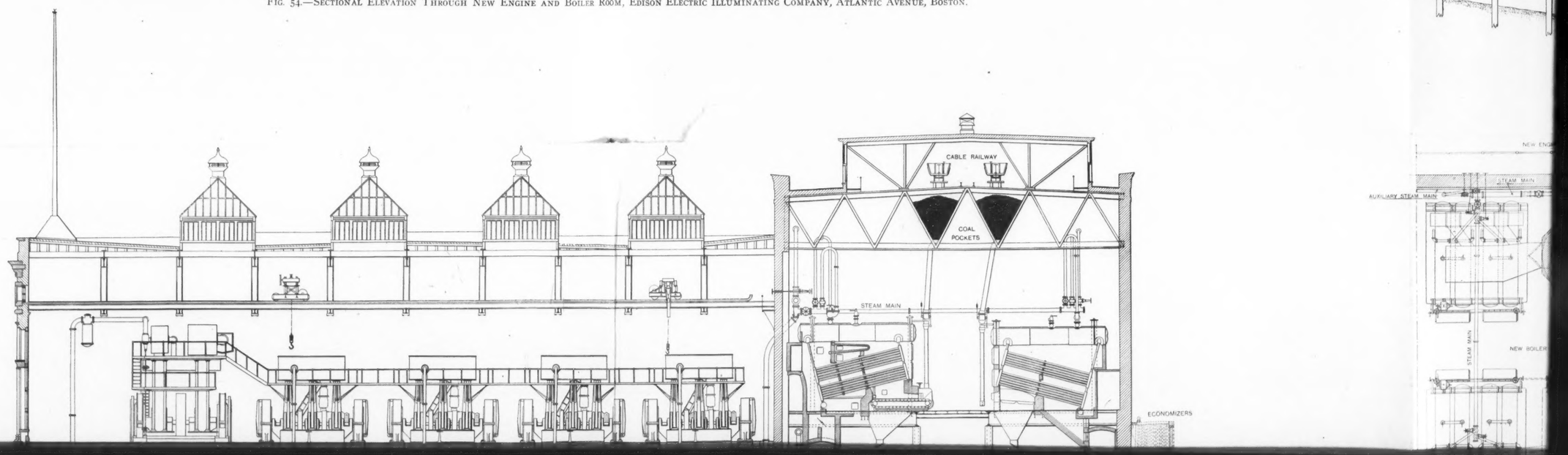


FIG. 54.—SECTIONAL ELEVATION THROUGH NEW ENGINE AND BOILER ROOM, EDISON ELECTRIC ILLUMINATING COMPANY, ATLANTIC AVENUE, BOSTON.



72 FOOT BOOM

62 FOOT BOOM

CANTILEVER TOWER

CABLE RAILWAY

COAL STORAGE

CABLE RAILWAY

COAL POCKET

COAL STEAMER

MEAN LOW WATER

ECONOMIZERS

NEW ENGINE ROOM

OLD ENGINE ROOM

STEAM TIE LINE

STEAM MAIN

AUXILIARY STEAM MAIN

NEW BOILER ROOM

OLD BOILER ROOM

FEED PUMP

OPEN HEATER

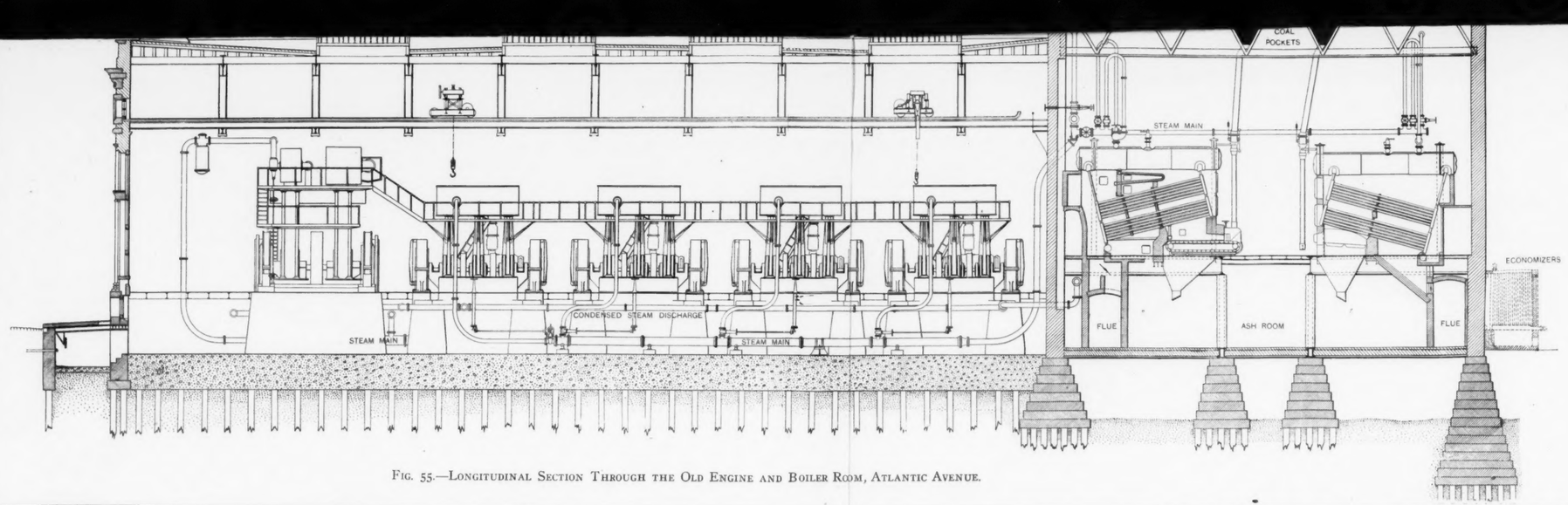


FIG. 55.—LONGITUDINAL SECTION THROUGH THE OLD ENGINE AND BOILER ROOM, ATLANTIC AVENUE.

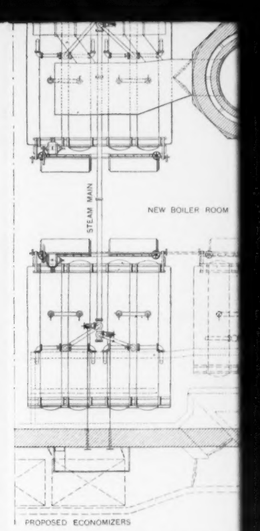


FIG. 56.—PLAN OF BOI

THE EDISON SYSTEM IN BOSTON—ITS DEVELOPMENT AND PRESENT STATUS.

(*See Page 797*).

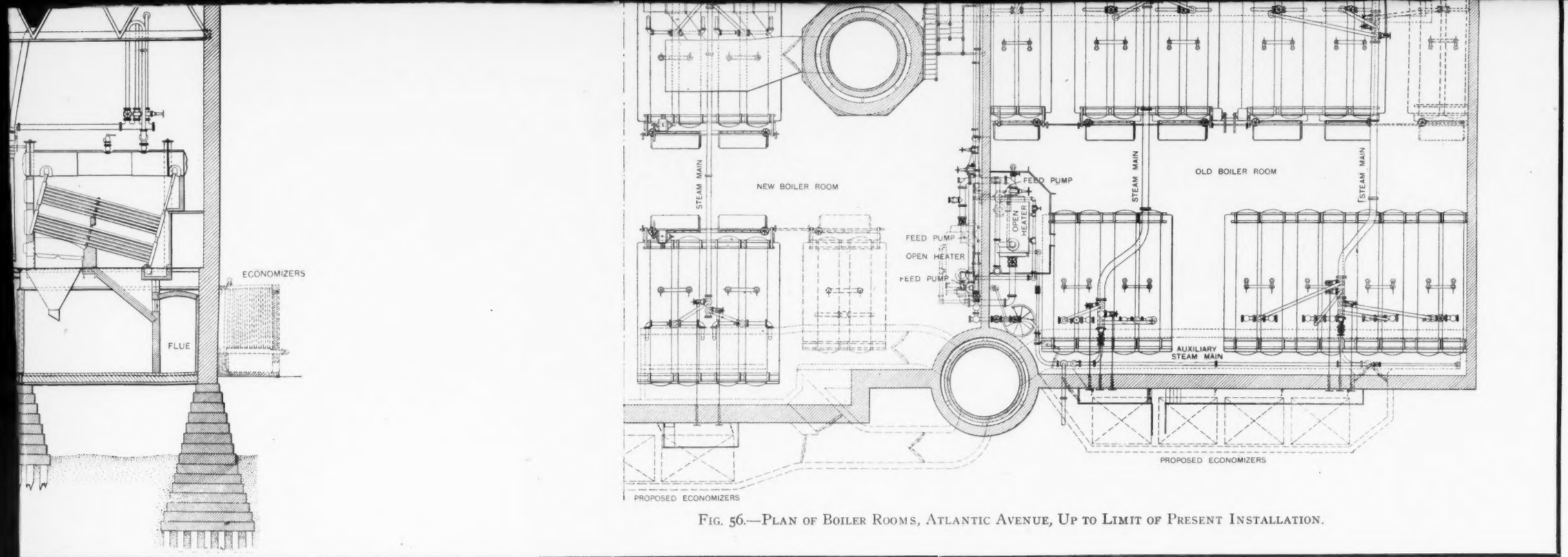


FIG. 56.—PLAN OF BOILER ROOMS, ATLANTIC AVENUE, UP TO LIMIT OF PRESENT INSTALLATION.

DEVELOPMENT AND PRESENT STATUS.

(Page 797).

sluiceway is 6 ft. in width, the bottom being covered with 16 inches of concrete, the top of which is grade minus 8. The top of the sluiceway is made up of 12 by 12-inch hard pine timbers, upon which rest 6-inch I-beams running under the floor along the width of the boiler room; under the wharf 12-inch timbers take the place of the I-beams. The top of the sluice outside is at grade 6, an inside section being 72 square ft. in area. On the top of this sluiceway is located a 48-inch discharge pipe, embedded in the concrete floor of the boiler room, the pipe having an elbow extending downward at the end, so that it is submerged at low tide.

There was a total of 13,500 cubic yards excavated in this work, and there was 62,000 cubic yards of concrete laid in the boiler and engine rooms. In several places where piles could not be driven under the walls it was necessary to use cantilever girdrs to transfer the load to positions where it was possible to drive piles.

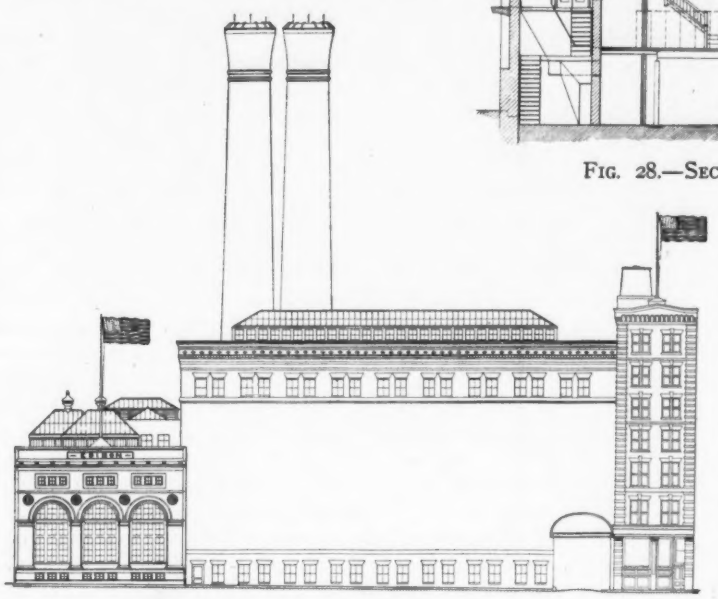


FIG. 26.—FRONT ELEVATION OF STATION AND SYSTEM BUILDINGS, ATLANTIC AVENUE.

At the southwest corner of the engine room, the column was so near to the System building that it was necessary to use a cantilever.

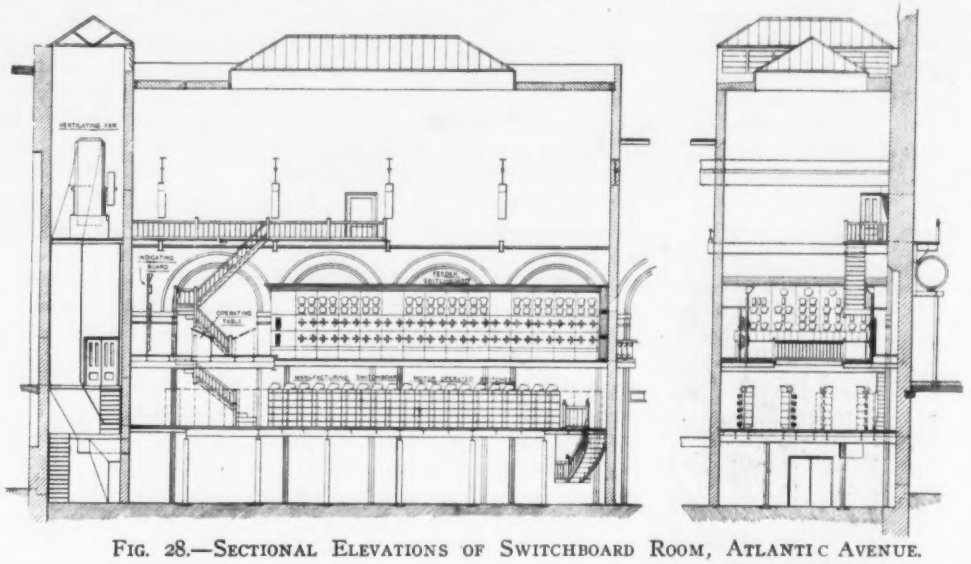


FIG. 28.—SECTIONAL ELEVATIONS OF SWITCHBOARD ROOM, ATLANTIC AVENUE.

This girder was composed of two plate girders, two feet deep, resting on three 20-inch I beams, which acted as a fulcrum. Under this fulcrum were 18 piles spaced about 2 ft. 6 inches on centres. The tail of the cantilever extended back far enough to catch the load from the next column, the other end extending under the wall of the System building. The piles were cut off at grade 6 and the concrete started at grade 5 and was built up around the girder and beams to grade 14. The top of the girder was set at grade 13 ft. 6 inches.

At the northwest corner of the engine room, the same method was followed, with the exception that in the place of plate girders four 15-inch I beams were used, the tops being set at grade 10 ft. 3 inches. The piles were cut off at grade 7 and concrete started at grade 6 and carried up to grade 11 ft. 10 inches.

At the southwest corner of the boiler room, a girder was required to span the sluiceway, which has an outside width of about 9 feet. This girder was composed of two plate girders 2 ft. deep, tied together by four plates. The girder was set on concrete with the top at grade 12. The portion of the sluiceway which passes through the boiler house is spanned by 6-inch I beams, 2 ft. on centres. The ends of these beams rest directly on piles which are cut off at grade 5 ft. 6 inches.

Where the sluiceway passes under the easterly wall of the boiler house, the wall is supported by three 6-inch I beams, 28 ft. long.

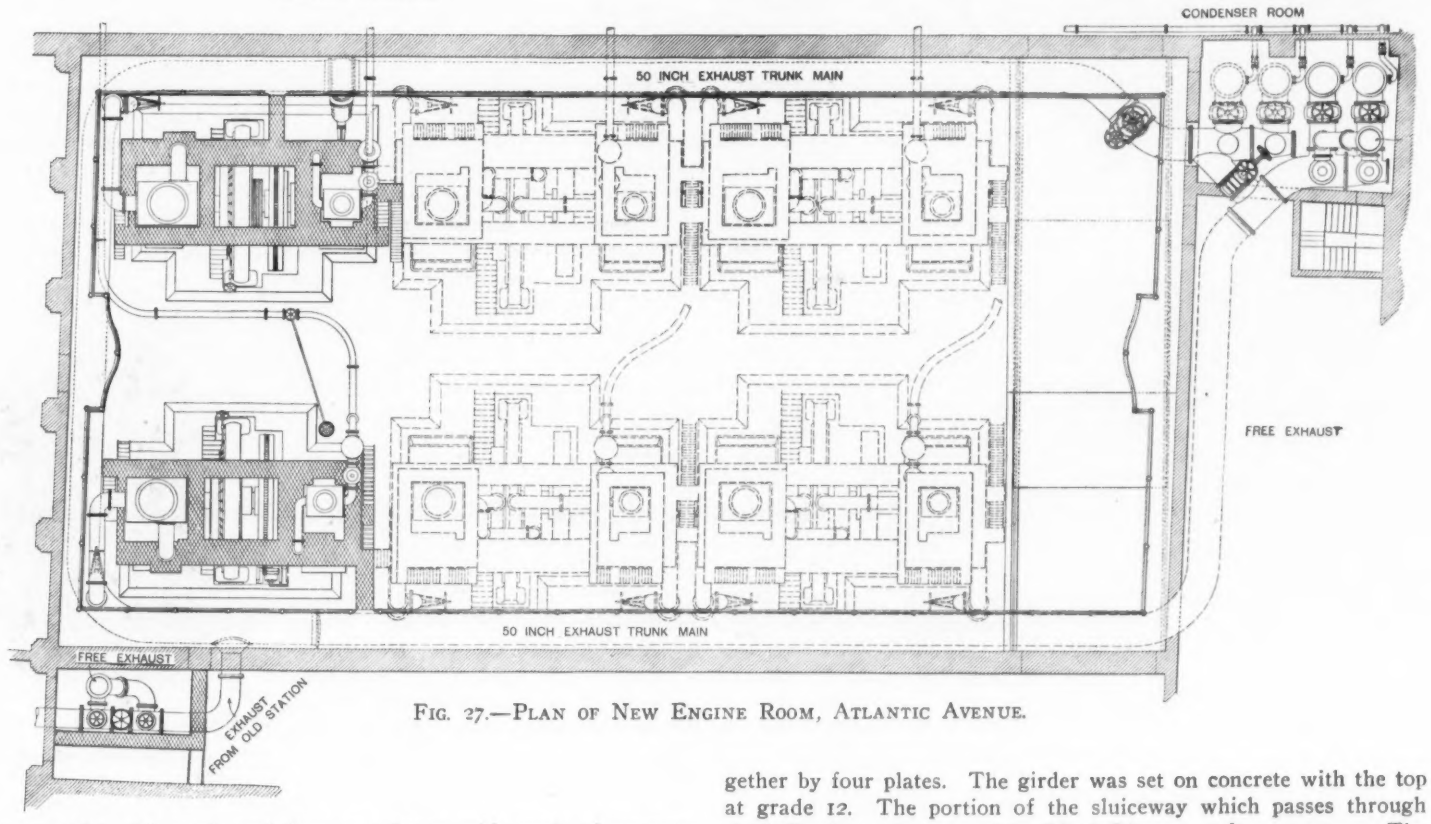


FIG. 27.—PLAN OF NEW ENGINE ROOM, ATLANTIC AVENUE.

which rest directly on piles. These beams are set at the same level as the beams over the sluiceway.

At the southwest corner of the boiler house, the old wall was found to be in very poor condition, and as there were two columns which had to bet set into it, it was thought necessary to improve the foundations under the same.

This had to be accomplished by means of beams, located as follows: Under one column, seven 20-inch I beams, 28 ft. long were laid transversely under the old wall, projecting under the engine house about 6 ft., where they were supported on three 10-inch I-beams, under which piles had been driven about 2 ft. on centres. The other ends of these 20-inch I-beams were supported on a cluster of piles about 15 ft. from the inside of the old boiler house wall.

FIG. 29.—THE STEEL FRAMEWORK.

Under the other column, three 20-inch I-beams, 18 ft. long, were laid diagonally from the corner of the engine house. These beams rest on two 10-inch I-beams, 14 ft. long, which were set parallel to the northeast wall of the engine house and also on the three 10-inch I-beams previously mentioned. Under all of these 10-inch I-beams piles were driven about 2 inches on centres. Three 20-inch I-beams 14 ft. long were put in to support the northeast wall of the engine house. These beams rested on the two 10-inch I-beams previously mentioned and extended underneath the engine house floor.

BUILDINGS.

The new buildings cover an area of about 150 by 160 ft., and are of the most modern fireproof construction. Under the walls of the building, resting on the concrete, is a granite foundation 3 ft. 8 inches wide and 20 inches thick, from the Stony Creek Quarry, Connecticut. Under the columns were placed granite levelers 4 ft. square, having a thickness of 20 inches.

The engine house roof is supported by nine trusses, resting on columns in the walls, spaced 16 ft. apart. The frame is entirely of steel, made by the Passaic Rolling Mills, Paterson, N. J. The trusses are of the Warren type, with the sloping top chords, which conform to the flat pitch of the roof. The span of these trusses is about 84 ft. centre to centre bearing. The main roof consists of 10-inch flat terra cotta arches on I-beam and channel iron purlins, which are riveted to the top chords of the trusses. Over these arches there were laid in successive layers 2 inches of concrete, 1 inch of Portland cement and a 5-ply composition roof. A monitor 110 ft. long and 20 ft. in width runs along the centre of the building. This monitor is covered with wire glass supported on I-beams and channel iron purlins, and on the sides by angle iron studs. All the woodwork throughout the building is covered with 16-oz. sheet copper, the copper work being done by S. D. Hicks & Son, of Boston. Along both sides and ends of the monitor, on the inside, a footwalk with hand-railing is provided. The trusses are braced by means of angle iron struts running lengthwise of the building and diagonals in two bays, at the level of the bottom chord. The sides and top of the monitor are braced in the same bays by diagonal rods.

The columns supporting the engine house roof are about 84 ft. high, the foot of each being set at grade 13 ft. 6 inches. At grade 77 ft. 10 inches the crane track girder rests on the columns. Below the crane track the column section is composed of two 12-inch channels (flanges turned in) riveted to a 23¼-inch web plate by means of four 4 by 4-inch angles.

Above the crane track the section is composed of one 12-inch channel, two 4 by 4-inch angles, two 6 by 4-inch angles and one 7½-inch web plate. At the level of the bottom of the crane girders, the columns are held by horizontal struts, each composed of two 4 by 4-inch angles latticed.

The engine room walls are built of Bay State brick, furnished by the Bay State Brick Company. They are 3 ft. thick up to the level of the crane girders, above which they are 16 inches thick for the rest of the height. Norton's Roslindale cement was used in the ratio of 1 to 2.

The crane track girders run along on the side walls of the engine room, and are supported by the columns at grade 77 ft. 10 inches. They are composed of four angles and a web plate, and are 3 ft. 2 inches deep. On the top flange is a 4 by 2½-inch steel bar, with the top planed and the corners turned to form the rail. This is attached to the flange of the girder by means of angle irons at intervals of about 3 ft. The rails are 80 ft. 10 inches, centre to centre.

At the southerly end of the engine room, 23 ft. above a driveway leading into the boiler room, is a sliding floor composed of a fixed portion under which the sliding portion passes. The sliding part is supported on 126 rollers, 3½ inches in diameter, which run upon a 5-inch 85-lb. rail. The rollers are set 12 inches on centre, and are held together by a harness consisting of bars 4 inches by ½ inch. The rails are spaced 20 ft. ¼ inch, centre to centre. These rails are supported by the wall on the northerly side, and upon the southerly side by eight angle iron posts, with brackets, and under the fixed portion by hangers riveted to the floor beams above. The sliding portion is made in two parts, each composed of 5/8-inch plate, riveted to 15-inch I-beams. These I-beams frame into longitudinal beams, to the bottom flange of which is riveted a track bar running on the rollers. The fixed portion is composed of 15-inch I-beams resting on the walls with two ring segmental brick arches.

The 50-inch exhaust pipe passing around the inside of the engine room walls on three sides of the building is supported on the main columns in the wall, and on 6-inch plate and angle columns set about 3½ ft. in from the wall. The small columns are composed of four 3 by 3-inch angles and one 6-inch web plate. Four columns on each side of the engine room run to the basement floor. They are braced at the engine floor level by means of angle iron struts, riveted to the sides of the columns and set into the wall. The pipe rests on two 8-inch channels riveted to the wall columns and cantilevering over the small columns. To allow for the expansion and contraction of the pipe at the points of support there are provided planed bed plates, riveted to the 8-inch channels.

Over this exhaust pipe, at grade 51 ft. 6 inches, is a gallery passing entirely around the engine room. In the centre of the ends of the building, there are balconies which are supported by brackets. The gallery is composed of channel iron stringers and angle iron floor beams, on which rests a flooring of slate 2 inches thick. At the southerly end it is supported by curved brackets which are held to the wall by means of anchor bolts. Elsewhere the gallery is supported by angle iron posts riveted to the channels which support the exhaust pipe.

The walls of the engine room from the engine room floor to the tops of the doors above the gallery are tiled with a special tile made by the Grueby Faience Company. Tiles of a dark green color extend to a height of 2 ft. at the lower and upper border, the remaining area being of a cream color. Above the tiles the plain walls are tinted a light cream color. The walls of the old engine room are finished in a like manner.

The ceiling is plastered, and painted a cream color, as are also all the exposed ironwork in both engine and boiler rooms. The floor is tiled with octagonal red tiles, and small chocolate squares, with a black border 2 ft. wide around the room and also around the engines.

FIG. 30.—CHIMNEY BASE.

Besides the monitor already referred to, the engine room is lighted by a row of 10 windows 4 by 7 ft. in the basement toward the street, also a row of 8 windows 4 ft. by 7 ft. above the crane track on each of three sides of the building.

The boiler house roof is supported on 13 trusses of the Warren type similar to those of the engine house. These trusses vary in span, those over the old portion having a span of about 71 ft., centre to centre of bearings, while those over the new portion have a span of about 76 ft. The easterly ends of all the trusses rest on the wall, also the westerly ends of trusses over the old portion. The next two are supported by a latticed girder riveted to two of the engine room columns, and the remainder are directly supported by hte engine room columns. The trusses are braced in five bays in the plane of the bottom chords by angle iron struts and diagonal rods. The roof and sides of the monitor are braced in the same bays by diagonal rods. The roof of the new portion was ex-

tended over the old boiler room, being at a grade high enough to allow the new trusses being placed without disturbing the old ones.

The roof is flat and is provided with a monitor 40 feet wide, through which the cable road can run the whole length of the building. Under this monitor and passing through the roof trusses are the coal bunkers. The flat portions of both main roof and monitor are composed of flat terra cotta arches between I-beams and channel iron purlins, the roof being finished as in the case of the engine

FIG. 31.—VIEW OF CANTILEVER TOWER AND CABLE RAILWAY DURING CONSTRUCTION, ATLANTIC AVENUE.

room. The purlins are riveted to the top chords of the trusses and are tied together at intervals of about 6 ft. by ¾ inch tie rods. In the vertical side of the monitor, attached to angle iron studs, are wire glass windows, 4 by 7 ft., the woodwork being covered over with copper. Along both sides of the monitor, on the inside, there is a footwalk provided with a pipe handrail. This footwalk is composed of iron bars set on edge supported by the top chords of the trusses.

Extending the length of the building over the outside edges of the coal bunkers there is a partition of corrugated iron fastened to angle iron studs, making a dust-proof coal pocket, which prevents the coal

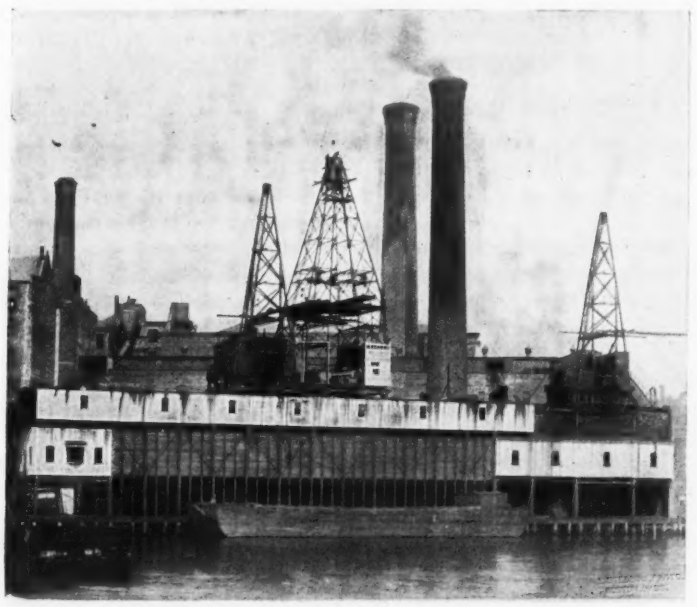


FIG. 32.—VIEW OF ATLANTIC AVENUE STATION, FROM THE WATER FRONT.

dust from getting into the boiler house. These studs are fastened to one of the roof purlins and the channel irons at the edge of the coal bunkers. Along the centre of each coal bunker, resting on the top chords of the trusses are four 6 by 12-inch hard pine stringers which form the tracks for the coal conveyor. The two coal bunkers are V-shaped, and pass directly through the trusses along the centre of the building. They are composed of ⅜-inch plates riveted to I-beams which are attached to the channel iron, forming the top flanges, and to the angle iron at the bottom forming the bottom flanges.

The two chimneys passing through the roof required special framing about them.

The walls are built of brick similar to those of the engine room, the thickness being, however, 3 ft. throughout their entire height.

The architects having charge of all this work were Winslow & Bigelow, of Boston, and the contractors were Norcross Brothers.

CHIMNEYS.

The twin chimneys which tower above the boiler house are identical above the roof, the only difference between them being that the base of the new chimney is octagonal in shape, whereas the old one is round. The new chimney is 200 ft. high, is octagonal at the base for the height of 55 ft., the outside diameter being 20 ft. between parallel faces. For the rest of the distance it is circular in shape, having a diameter of 14 ft. 7 inches just below the cap.

At the base the outside shell is 24 inches thick, and the inside shell 16 inches, leaving an air space of 11 inches between the two. The inside shell extends to a height of 135 ft., is 8 inches thick at the top, and is lined with firebrick for 55 ft. of this distance. The outside shell is 12 inches just under the cap. The inside diameter of the flue is 11 ft. 5 inches. The cap is of cast iron, and is made in 16 sections, weighing 250 lbs. each. They are bolted together with ¾-inch bolts, the joints being filled up with red lead and covered over with copper. Four lightning rods serve to complete the structure.

WHARF.

The addition to the wharf consisted in extending the wharf already existing, out to the line of the Harbor Commissioners. The wharf, as it previously existed, had an area of about 18,000 sq. ft., while the addition recently completed, together with Batchelder's wharf, gives a total wharf area of about 42,000 sq. ft.

In the extension there were driven in parallel rows 10 ft. apart and 4 ft. on centres 455 best quality oak piles, 65 ft. long and 14 inches in diameter 5 ft. from butt and 8 inches in diameter at tip. On top of the piles are two 8 by 14-inch hard pine girder caps, bolted to the top of each pile with two 1-inch screw bolts; bolted to these by 1-inch screw bolts are four 10 by 14-inch hard pine rider caps. Running crosswise on the riders are hard pine stringers 6 by 14 inches, laid 18 inches on centres, to which is securely fastened 4-inch spruce plank.

Under the driveway leading to this property from Congress Street there were driven 139 oak piles, 55 ft. long, having a diameter of 13 inches, 5 ft. from butt, and a diameter of 7 inches at the tip, girder capped by 6 by 12-inch hard pine, and having two 8 by 12-inch hard pine rider caps, above which are placed on 2-ft. centres 6 by 12-inch stringers covered by 3-inch spruce planks and 2-inch hard pine planks.

The piling both in the foundations and wharf was done by L. R. Tidd, of Boston. The harbor next to the wharf has been dredged to a depth leaving 25 ft. of water in the channel at low tide.

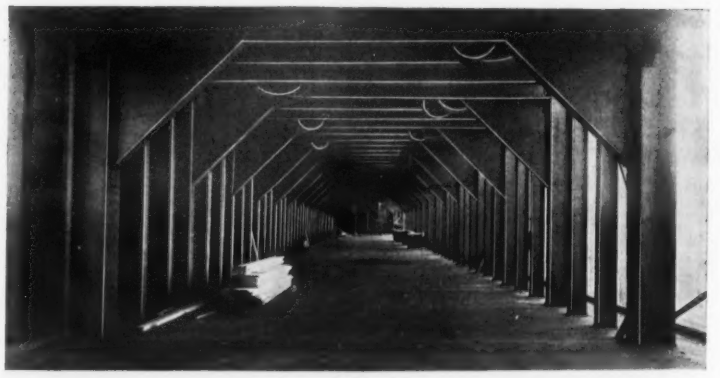


FIG. 33.—STEEL COAL POCKET AT END OF WHARF, ATLANTIC AVENUE.

STEEL COAL POCKET.

At the end of the wharf and running parallel to it is a steel coal pocket 144 ft. long 20 ft. wide and 17 ft. deep, having a capacity of about 1300 tons of coal. Beneath this pocket is a driveway 12 ft. high, used for loading teams with coal.

The total structure, including the coal pocket, is 246 ft. in length, and is supported by two sets of columns, the main ones being spaced 12 ft. on centres, the intermediate ones being placed at 4-ft. intervals between the main columns.

These main columns are built up of web and angle-iron construction, the webs being 15 by ⅜ inches and 42 ft. 7¾ inches long, the angles 5 by 3½ by ⅜ inches; the auxiliary columns consist of 9 by ¼ inches plate, 32 ft. 6 inches long. These latter columns extend up through the coal pocket, serving to support a part of this load, while the former extend the entire height of the structure, supporting the rails of the cable railway and also the coal towers above. Across the top of these columns are girders 24 ft. 11¼ inches in length, made up of 24 by ¼-inch webs and 5 by 3 by ⅜-inch angles, which support the rails. The main columns are braced by angles 2½ by 2½ by ¼ inches, running diagonally in the plane of the columns. The floor and sides of the coal pocket are made of 3-inch hard pine plank. There are 24 coal chutes built in the bottom of the coal pocket at regular intervals on both sides to facilitate the loading of coal teams on the wharf. This coal pocket was built by the New England Structural Company after plans by the Metropolitan Coal Company of Boston.

COAL TOWERS.

On top of the coal pocket, running on rails spaced 21 ft. 3¼ inches on centres are three coal towers, two of which are of ordinary form and construction, extending 70 ft. above the rails, and each being equipped with two Lidgerwood hoisting engines for operating the coal buckets.

The third consists of a steel cantilever tower 91 ft. high, 31 ft. 6½ inches long and 24 ft. wide, mounted on eight double-flanged wheels running on rails the entire length of the pocket, 43 ft. above the wharf. The main floor is constructed of 15-inch 42-lb. I-beams, resting directly on the trucks. The cross beams are 15-inch 33-lb. channels, while the diagonal bracing is effected by 12-inch 20½lb. channels. The uprights at the four corners are made up of two 6 by 4 by 9-16-inch angles, bolted together and extended about 30 ft. above the main floor beams to which they are secured. These uprights are braced diagonally with 3 by 3 by ⅝-inch angles. Thirty ft. above the main floor the columns are continued at an angle forming a square pyramid extending 55 ft. above, at the top of which are four 36-inch sheaves hung on a swivel, over which run the main hoisting ropes. The boom is of steel construction and extends out on each side of the coal tower, the land side being fixed and extending 72 ft. from the centre of the tower. The water side of the boom extends 62 ft. from the centre of the tower, and is so constructed that it can telescope the land side of the boom. The coal bucket can travel the entire length of the two sections of the boom, so that coal may be taken from a barge on the water side, and discharged into the hopper of the coal pocket, or it may be carried farther and emptied into a coal shed on the land side of the tower. In like manner the coal may be taken from the coal shed and discharged into the coal pocket, or loaded on to a barge at the end of the wharf.

The hoisting machinery in the tower is electrically driven. The main hoist consists of two drums of the standard friction type, running at a speed of 900 ft. per minute, hoisting a load of 7750 lbs. The drums and armatures are on the same shaft, each drum being driven independently by a 100-hp, 250-volt multipolar motor running at 150 r. p. m. The trolley hoist located on the opposite side of the tower consists of two drums on the same shaft, one being loose, the other keyed to the shaft, the power being transmitted by means of a positive 4-jaw clutch. Directly connected to each end of the drum shaft is a 40-hp, 250-volt multipolar motor, operating at about 200 r. p. m. This cantilever tower, as well as the two smaller towers, was built by J. H. Procter & Co., of Boston.

Besides the coal pocket already described having a capacity of 1300 tons, there is a coal shed on the old portion of the wharf capable of storing 4200 tons, and a coal yard on the land side of the coal pocket having a capacity of 4500 tons, so that the entire wharf as now constructed is capable of storing 10,000 tons of coal.

CABLE RAILWAY.

The coal is conveyed from the coal wharf to the boiler room by means of a cable railway, which runs along the top of the coal pocket over a trestle having an 8 per cent grade, into the south end of the boiler room, along the length of the boiler room and down to the coal pocket again. There is also a loop which supplies coal to both of the wooden coal sheds. Along the top of the coal pocket and throughout the length of the boiler room there is a double track, there being in all about 2000 ft. of single track. The trestle is made up of hard pine bents, having posts 10 by 10 inches at the lower end and 12 by 12 inches at the higher end, being braced by 4 by 8-inch hard pines fastened by ¾-inch bolts.

The tracks have a gauge of 21½ inches, being made up of 16-lb T-rails, the curves having a radius of 12 ft., with horizontal pulleys for guiding the cable.

The cars, 10 in number, are 8 ft. 6 inches long, 5 ft. 1 inch wide at the top and 3 ft. 8 inches wide at the bottom, and 5 ft. 3 inches deep. They each run on 8 wheels, weigh 1¼ tons, have a capacity of 2½ tons, and have sides which open out to discharge the coal, this being regulated by a trip located in any desired position.

Each car is provided with a stop which works the automatic switch thus putting the car on the desired track in the boiler room. The cars may be loaded with coarse or fine coal by regulating the screens in the tower. Two men can operate this system, one man being required to ungrip the cars the other to load and grip again.

Steel hoisting cable ¾ inch in diameter is used to propel the cars, this cable being driven at a speed of about 200 ft. per minute by a 12-ton cable drive, consisting of a system of gears and pulleys, which is operated by an electric motor. The device for taking up the slack wire consists of a movable pulley, around which the cable passes, traveling on a horizontal track. The cable is kept taut by means of a weight connected to the movable pulley by a cable passing over an auxiliary pulley. This cable railway was built by J. H. Procter & Co., of Boston.

BOILER ROOM.

The floor of the old boiler room is 15 ft. above the ash room floor, and is supported on horizontal box girders 18 inches wide by 31 inches deep, these being tied together by plate girders running transversely, 16 inches wide by 36 inches deep. These are supportd by two rows of box columns 18 inches square.

In the new boiler room the supports are built up on a basis of separate units of two boilers each. Under each side wall are placed three 15-inch I-beams, while under the centre walls there are placed three 20-inch I-beams. The main floor is made up of brick arches, resting on beams. The stoker pit runs across the width of the boiler room from one set of boilers to the other.

The boilers are located in rows extending from north to south of the boiler room, there being seven boilers on the water side of the room and eight on the engine side, the chimneys being situated between the old and new boilers. The boiler room equipment consists of seven double-deck water-tube boilers, built by the Babcock & Wilcox Company, having a nominal capacity of 368 horse-power each. Each boiler consists of two drums 42 inches in diameter and 22½ ft. long, containing 14 sections of 12 tubes each, providing a water-heating surface of 2680 sq. ft. The grate is 8½ ft. wide and 7 ft. long, giving a grate surface of 59½ sq. ft. The ratio of the heating to the grate surface is 62.6. Two of these boilers are fitted with the Hawley down-draft furnace.

There are also installed eight double-deck Babcock & Wilcox water-tube boilers of a nominal capacity of 418 horse-power. These are made up of two 42-inch drums, 23 ft. 3 inches long, having 16 sections of 12 tubes each, the tubes being 4 inches in diameter and 18 ft. long. The water-heating surface is 4181 sq. ft. and the superheating surface is 376 sq. ft.

These boilers are equipped with Babcock & Wilcox chain grate stokers, 90 by 111 inches, providing a grate surface of 69.4 sq. ft. The stokers are driven by 7½-hp, 220-volt motors, having a speed of 300 r. p. m., made by the Bullock Electric Manufacturing Company, of Cincinnati, Ohio. The motor is geared to a jack shaft, having a speed of 70 r. p. m., which can be varied 12½ per cent either side of normal by means of a motor starting box.

There is an eccentric on the jack shaft with a rod connecting down to a rocker arm carrying a pawl, which engages a tooth wheel driving a worm, which in turn drives a gear fastened to the main sprocket shaft of the grate. These stokers are guaranteed to run successfully under continuous load at a temperature of not less than 150 degs. F. There is space in the new boiler room for an extension of the boiler plant whenever it becomes necessary to utilize it. The ashes are discharged from the furnaces through chutes to the ash room below the boiler room floor, and then carted away. On the water side of the space beneath the boilers there are two rooms partitioned off, one for the circulating pumps and the other for the feed-water pumps.

There are three M. T. Davidson compound tandem, non-condensing circulating pumps, which supply the surface condensers with water from the harbor, the water ends being lined with composition metal to prevent any action of the salt water on the pipes. Two of the pumps have steam cylinders of 10-inch and 20-inch diameters, water cylinders 20 inches in diameter and 24-inch stroke, with 14-

inch suction and discharge pipes. The other pump has steam cylinders 7 inches and 14 inches in diameter, a 14-inch water cylinder and a stroke of 16 inches, the suction and discharge pipes being 10 inches in diameter. The feed pump room contains two Davidson, simple pumps, each having a steam cylinder 14 inches in diameter and a water cylinder 8¼ inches in diameter, with a stroke 14 inches, making 86 strokes per minute; also two Blake, vertical compound duplex pumps with steam cylinders 10 by 16 inches in diameter and water cylinders 8 inches in diameter, having a 10-inch stroke. There are also installed and ready for use, if necessary, 10 Korting universal injectors.

The feed water for the boilers is taken directly from the city mains, the pipes in the street being so arranged that it would be almost impossible for the supply to fail. The main service pipe is 12 inches in diameter, having a water pressure of 40 lbs. There is also a 12-inch high-pressure main, which can be used in case of emergency. From the city mains the water flows through a Goubert exhaust feed-water heater, after which it passes into a Cochrane open heater, where it is heated by direct contact with the exhaust steam from all the auxiliaries; from this heater it is pumped into the boilers by the feed-water pumps. There is being drilled at the present time, just outside the boiler room, an artesian well, which has already been sunk 500 ft., and if this well should supply the proper quality of water, it will be used as a partial supply for the boilers. On the outside of the boiler room towards the wharf, a space has been reserved for economizers, but at the time of writing they have not yet been installed.

FIG. 34.—NEW BOILER ROOM, ATLANTIC AVENUE.

CONDENSER ROOM.

At the southeast corner of the engine room, at the end of the System building, is the condenser room of the central condensing system. There are installed here two Blake twin vertical air pumps (inverted) of the regular marine type, having steam cylinders 16 inches in diameter and buckets 44 inches in diameter, with a common stroke of 24 inches. These pumps take the water and condensed steam from the Knowles jet condensers, which are of the cone type, located below, and discharge it into the harbor through the 48-inch discharge pipe located on top of the sluiceway. The salt water from the channel flows through the sluiceway, already described, into the jet condensers, where it is met by the exhaust steam from the engines which has passed through the 50-inch condenser pipe, running around the engine room under the gallery, and also through Goubert feed-water heaters, consisting of a number of brass pipes conducting the feed water, surrounded by a chamber through which the condensed steam passes. The 50-inch exhaust main is furnished with two 30 and 36-inch free-air exhaust pipes, having Sturtevant exhaust heads. When the condenser room is completed it will have double its present capacity.

ENGINES.

The engine equipment at the Atlantic Avenue Station consists of four 660-hp vertical triple expansion engines, each driving two 200-kw generators; one 1200-hp engine driving two 400-kw generators; two 1200-hp engines, each driving one 800-kw generator, and two 2400-hp engines, each driving one 1600-kw generator. The four 660-hp engines were built by the J. Morton Poole Company of Wilmington, Del., after plans by the Edison General Electric Company. They are all of the triple expansion condensing, vertical type, directly connected to the generators, one at each end, the armature acting as flywheels. These engines are run at 120 revolutions per minute, the pressure being 160 pounds. The diameters of the cylinders are 16¼ inches, 23⅞ inches and 38½ inches, respectively, the stroke being 30 inches The piston rods are all 3¼ inches in diameter. The high pressure rods are all packed with "Tripp" metallic "two-four" packing, the intermediate and low pressure rods having soft packing.

The engines stand 18 feet 3 inches above the floor, which is three feet above the top of the brick foundation. The engines are fitted with piston valves, and have centrifugal governors on the crank shafts between the crank disks. The cylinders are steam-jacketed and lagged and are surrounded by a sheet iron casing. Each engine is provided with a Wheeler surface condenser and a Knowles combined circulating and air pump, which are located in the rear of each engine.

Engine No. 5, located at the end of the row of engines just described, is of the vertical cross compound type, designed and built by McIntosh, Seymour & Company, of Auburn, N. Y. It runs at 100 revolutions per minute on 160 pounds steam pressure. It is rated at 1200-ihp and has a total weight of 254,000 pounds. The diameter of the wheel is 12 ft. and its weight is 40,000 pounds. The principal dimensions of the engine are as follows: Diameter of outside main bearings, 14 inches, length 30 inches; diameter of inside main bearings, 14 inches, length 20 inches; diameter of crank, 15 inches, length 8 inches; diameter of crosshead pin, 7 inches, length 9 inches; bearing surface of crossheads, 17x20 inches; diameter of piston rods, 5 inches; diameter of steam pipe, 8 inches; diameter of exhaust pipe 20 inches.

The engine is guaranteed to regulate from no load to full rated load within two per cent. variation of speed. The guaranteed water consumption, including steam condensed in jackets and reheater coils, is 13¼ pounds per indicated horse-power. The high pressure cylinder is jacketed and a reheater consisting of heating coils having 440 square feet of heating surface is connected between the cylinders. These auxiliaries are supplied with steam at boiler pressure. Both cylinders are four-ported, and are provided with valves of the flat gridiron type of standard form. The clearance in the high pressure cylinder is 2 per cent, and in the low pressure 3 per cent.

The main valves are driven by an eccentric, controlling the admission of the steam and the opening and closing of the exhaust. The cut-off of the steam is effected by the cut-off valves which are controlled by a centrifugal governor situated on the main shaft of the engine.

The valve gear is positive, composed of simple levers and links,

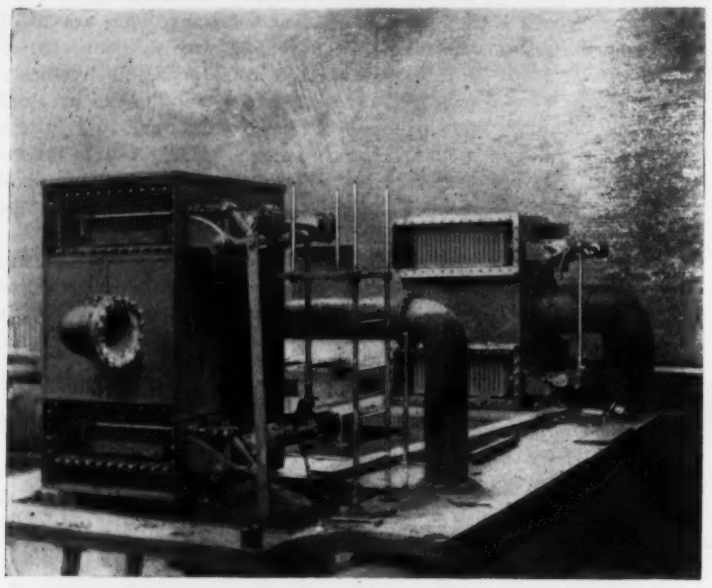


FIG. 35.—VALVES AND STEAM CHESTS, 2400-HP ENGINE.

and the cut-off can take place at any point between zero and the maximum cut-off. Piston rods of both cylinders are furnished with "Tripp" metallic packing, they are also provided with auxiliary glands for the use of soft packing. The throttle valve is a quick opening valve of the double poppet, balance type, operated from the floor level by an operating wheel provided with a crank handle. The main steam pipe to the engine is fitted with an 8-inch direct separator.

Directly behind the engine is located a Wheeler surface condenser consisting of 1450 tubes 10 ft. 2 inches long and having an outside

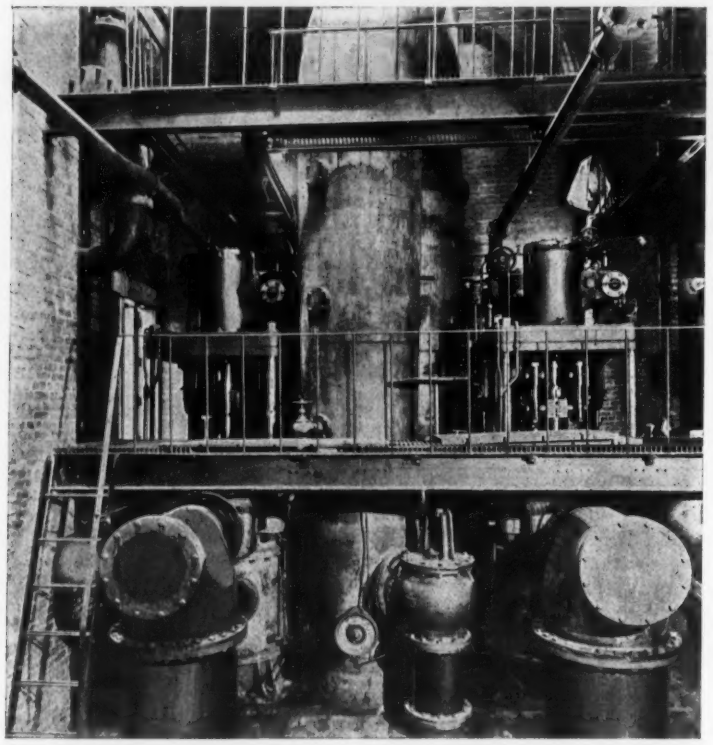


FIG. 36.—VIEW IN CONDENSER ROOM OF THE CENTRAL CONDENSING SYSTEM, ATLANTIC AVENUE.

diameter of ⅝ inch. There is also provided a vertical twin bucket pump built by the George F. Blake Manufacturing Company, having a steam cylinder 9 inches in diameter and a water cylinder 18 inches in diameter and a stroke of 12 inches.

In the same end of the engine room on the opposite side and facing engine No. 5 are two 1200-hp engines numbered 6 and 7, which are alike in all respects and are arranged to drive one 800-kw dynamo each, situated on the engine frame between the high and low pressure engines. The engines are of the vertical cross-compound, side crank type, were built by McIntosh, Seymour & Co., run at a speed of 100 revolutions per minute, and have each the following dimensions:

Diameter of high-pressure cylinder, 23 inches; low pressure, 48 inches; stroke, 48 inches. Total weight of engine, 275,000 pounds. Weight of wheel, 65,000 pounds; diameter of wheel, 15 feet. Diameter of bearings, 17 inches; length of same, 35 inches; diameter of shaft between bearings, 20 inches; diameter of crank pin, 8 inches, length 8 inches; diameter of crosshead pin, 7 inches, length 8 inches; bearing surface of crosshead 17 x 20 inches; diameter of piston rod 3 inches; diameter of throttle 9 inches, main steam pipe 10 inches, exhaust pipe 20 inches.

The engine is guaranteed to regulate from no load to full rated load within 2 per cent. variation of speed, and not to consume more than 13¼ pounds of dry steam per indicated horse-power per hour when running at full load.

The cylinders and steam chests are lagged with magnesia fibre and sheet steel. Between the two cylinders is located a reheater containing about 440 square feet of heating surface supplied with

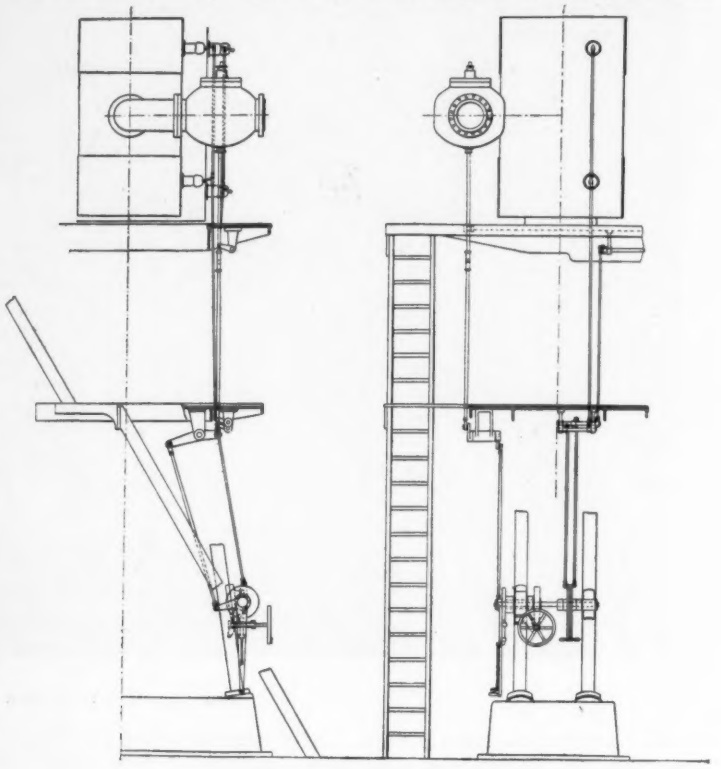


FIG. 37.—THROTTLE AND DRIP CONNECTIONS 2400-HP ENGINES.

steam at boiler pressure. The cylinders are four-ported and provided with standard flat gridiron valves. The high-pressure cylinder has a clearance of 2 per cent, the low pressure 3 per cent.

The valve gears and governors are of the same type as No. 5 previously described. The bearings are hollow and provided with a circulation of water. They are also each provided with two sight feed oilcups in addition to the oil which is supplied the bearings by means of a brass oil pump driven from the valve gear. The crank pins, crosshead pins, guides and wipers are oiled continuously by means of a supply tank situated upon the upper platform connected by a system of brass piping to an adjustable sight feed outlet to each part to be lubricated.

The engines are equipped with Cochrane receiver separators and have throttle valves of the quick opening piston type.

At the rear of each engine is a Wheeler surface condenser having 1186 tubes 10 ft. 2¼ inches long and ¾ inches in diameter. Also a Blake air pump similar to the one on No. 5 engine. These two engines are piped to connect with the central condensing system if required. All the engines can be run with open-air exhaust if necessary.

The latest units installed by the company consist of two McIntosh & Seymour 2400-hp engines, each driving one 1600-kw generator. These units are situated, as shown on the plan, in the end of the new

engine room next to the switchboard room and are so placed as to face each other. The engines are of the vertical cross-compound side crank type, run at a speed of 100 r. p. m. on a pressure of 160 lbs., and have the following dimensions in common: Diameter high-pressure cylinder, 29 inches, of low pressure, 60 inches, stroke 56 inches. The total weight of engine 500,000 lbs., weight of wheel 130,000 lbs., diameter 18 ft. Diameter of bearings, 24 inches, length 48 inches; diameter of shaft between bearings 27 inches; diameter of crank pin 12½ inches, length 10½ inches; diameter of crosshead pin 10½ inches, length 10½ inches; bearing surface of crosshead 21 x 25 inches; diameter piston rod, 6 inches; diameter steam pipe 10 inches, of exhaust pipe 24 inches.

The speed is guaranteed to within a variation of two per cent. from no load to full load, and the engines are guaranteed to operate on a maximum steam consumption of 12¾ lbs. per hp per hour, including steam condensed in jackets and reheaters.

Between the two cylinders is located a reheater having a total heating surface of 800 sq. ft. The clearance in the high-pressure cylinder is 2¾ per cent and 4 per cent in the low-pressure cylinder. The throttle valve is of the quick opening piston type, operated by a set of levers, a sketch of which is shown on another page.

The engine is provided with a turning gear operated by a 5-hp, 220-volt, General Electric motor, attached to the rear of the engine bedplate, supplied with a controller and rheostat giving five running speeds, the minimum being 200 and the maximum 960 r. p. m.

The valves, governors and other details of these engines are similar to those of the 1200-hp engines, previously described. The engines are connected with the central condensing system by a 50-inch pipe extending around the room beneath the gallery. The space in the new engine room now unoccupied will be utilized in the future as necessity requires. It is proposed, at the time of writing, to fill this space with 4000-hp engines, of similar type, driving 2500-kw direct-connected generators.

STEAM PIPING.

All of the copper pipe and most of the screw flanges, as originally installed, have been discarded and are now replaced by steel pipes with flanges welded on. All the high-pressure steam pipe is made up of tongue and groove joints with copper gaskets, all the fittings being made of air-furnace gun iron, having a tensile strength of 30,000 lbs. per square inch. The company has its own standard for flanges, bolting, etc., those used being heavier than others found in common practice. The main steam pipe is anchored at certain definite points, so as to control the direction of expansion.

From the steam outlets on the boilers 6-inch vertical loops, carried up high above the boilers in order to give the desired flexibility, connect to the steam mains which vary from 8 to 12 inches in diameter. These mains run crosswise of the boiler room, discharging into short 12-inch headers parallel with and supported on the side wall between the boiler and engine rooms. From these headers, which are connected by means of 8-inch equalizing loops, the pipes lead directly to the engines.

The engines in the old room are divided into two groups, each one on a 12-inch main, the four triple-expansion engines being fed from one main and the three 1200-hp compound engines from the other. In the new engine room each engine has its own pipe connecting to one of the headers. Each engine has, besides its quick-acting throttle, an outside gate valve geared to a floor stand convenient to the engineer standing at the throttle. Each boiler is provided with an automatic stop check to prevent the back flow of steam in case of a drop in pressure or a rupture in the boiler. Each boiler has a stop valve which is geared to a position on the outside of the boiler room wall, where it can be operated in case of an accident in the boiler room.

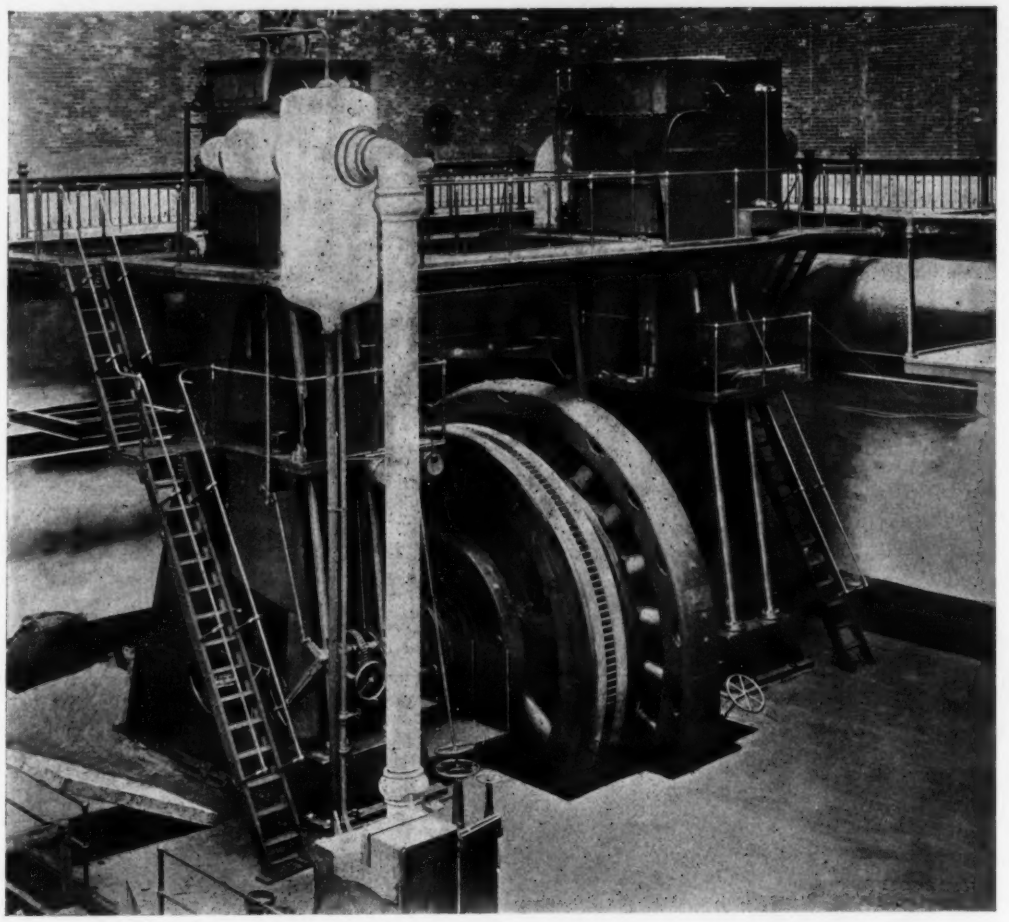


FIG. 38.—2400-HP MCINTOSH & SEYMOUR ENGINE AND 1600-KW G. E. GENERATOR IN NEW ENGINE ROOM, ATLANTIC AVENUE.

All the auxiliary apparatus, like feed pumps, circulating and air pumps, are fed independently from the boilers by means of a 6-inch pipe. All the high-pressure drains from the engines and main steam pipes are returned to the boilers by the Holly system.

CRANE.

In the engine room, running the length of the room on tracks already described, is a 50-ton overhead traveling crane, built by the Morgan Engineering Company, of Alliance, Ohio. This crane is one of the largest in existance, having a span of 80 ft. 10 inches, one piece of the crane weighing 40,000 lbs. It is provided with two hoists. The main hoist having a capacity of 50 tons, with a maximum lift of 56 ft. and an auxiliary hoist of 5 tons capacity and a lift of 62 ft. The main hoist has a speed of 11 ft. per minute, full load, the

speed increasing with decrease of load. The auxiliary hoist has a speed of 50 ft. per minute. The cross travel varies from 80 ft. to 100 ft. per minute, and the longitudinal travel from 100 ft. to 150 ft. per minute.

The armature of the hoisting motor has an automatic electric brake, operated by solenoids, and applied by gravity so that if the current should fail from any cause, the brake would immediately apply itself and prevent the running down of the load. The main hoist is also supplied with a mechanical brake. The crane is operated by four 220-volt General Electric enclosed multipolar electric

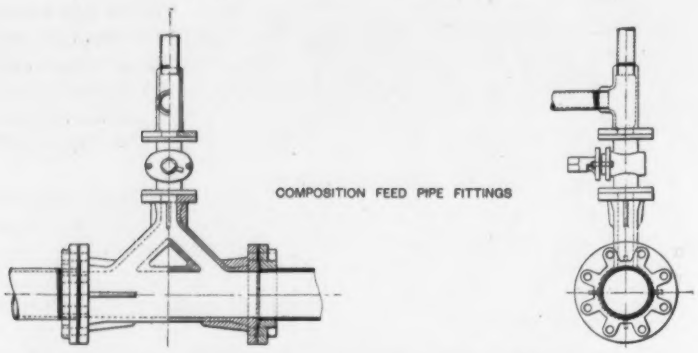


FIG. 39.—COMPOSITION FEED PIPE FITTINGS.

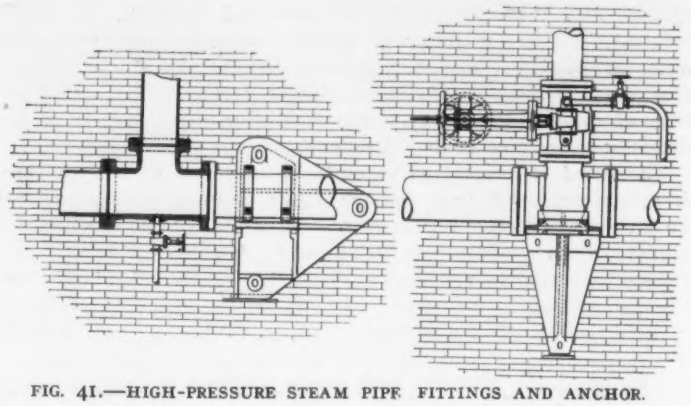


FIG. 41.—HIGH-PRESSURE STEAM PIPE FITTINGS AND ANCHOR.

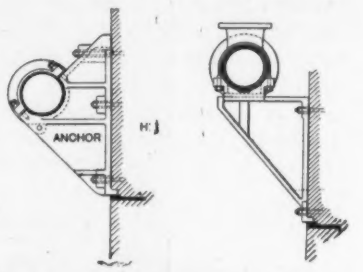


FIG. 42.—HIGH-PRESSURE STEAM PIPE FITTINGS AND ANCHOR.

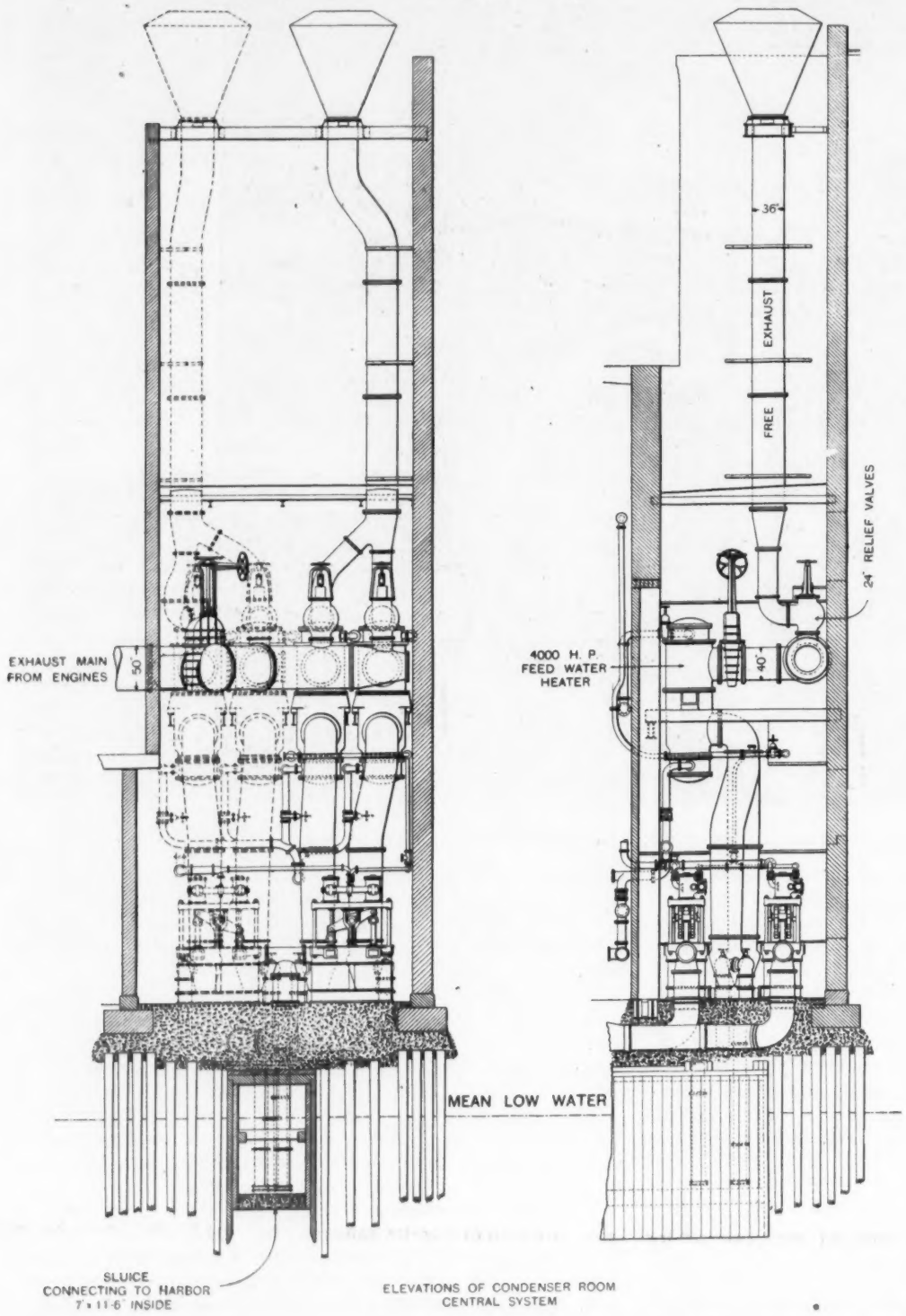


FIG. 40.—ELEVATIONS OF CONDENSER ROOM, CENTRAL SYSTEM.

motors of different capacities. as follows: Main hoisting motor, 50-hp, auxiliary hoisting motor 25 hp, trolley travel 5 hp and the bridge travel 30 hp.

The motors are all controlled from a cage suspended from the crane, in which are installed four Morgan lever controllers, and reversing switches. This crane can pick up the heaviest piece which

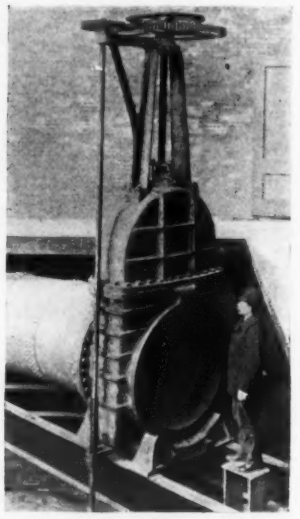


FIG. 43.—CHAPMAN VALVE IN MAIN CONDENSER PIPE, ATLANTIC AVENUE STATION.

comes into the station from a dray in the driveway, lifting it through the sliding door opening and depositing it in its required position without its being removed from the hoisting hook.

GENERATORS.

All of the generators installed at this station are of the direct-connected type, the first four having been designed and built by the Edison General Electric Company, the remainder by the General Electric Company, at Schenectady, N. Y. There are two generators on each of the four 650-hp engines of 200-kw each. They run at a speed of 120 revolutions per minute, develop 1333 amperes at 160 volts, and run on the three-wire system; one dynamo on each engine being connected to the positive and the other to the negative side of the system. The pole pieces, fourteen in number, are all connected in multiple and are bolted to the inside of the circular casting resting on the foundation bed of the engine.

The armature consists of a cast iron pulley, on the outside circumference of which is bolted and keyed a brass rim about 1 inch thick, having spokes which carry the laminated core and the winding.

The winding consists of 980 sections, each being composed of a heavy U-shaped copper bar which, with one section of the commutator, forms one complete turn around the laminated core, the commutator being on the side of the armature. The fourteen sets of brushes are supported on a circular frame, which revolves on a hub supported by three heavy cast iron arms, radiating from the centre and attached at the other ends to the field casting. There are two brushes on each holder composed of copper wire gauze, making contact on the commutator. A lever is provided on the front of the dynamo by which all the brushes can be lifted from the commutator simultaneously. By means of a hand wheel, all the brushes can be adjusted simultaneously, and in addition each brush can be adjusted individually.

Each consecutive brush is of opposite polarity and the brushes of similar polarity are connected together by three strands of copper cable. The current is carried to the main switchboard by means of heavy flexible cables. There are, in series with the fields, rheostats which are controlled in the regulating room.

The diameter over the fields is 10 ft.; of the armature is 7 ft.

The 1200-hp engine, numbered 5, is equipped with two 400-kw generators which are very similar to those just described, the only radical difference being that they are double the capacity.

The dynamos have 12 poles connected in multiple and develop 2857 amperes at 140 volts, running at a speed of 100 revolutions per minute.

The two 1200-hp engines numbered 6 and 7 are each equipped with one 800-kw generator, located on the bed of the engine, between the high pressure and low pressure crank.

The dynamo is run at a speed of 100 revolutions per minute and is guaranteed to develop 2666 amperes at 300 volts, or 2963 amperes at 270 volts. These machines furnish current to the outside wires of the three wire system. The frame consists of a circular cast iron yoke with 16 inwardly projecting poles of cast steel. The armature is of the ironclad or slotted core type, and is thoroughly ventilated by means of air ducts 3/8 inch in width. The armature spider is of best grade cast iron to which are keyed the laminations or punchings in such a way that no bolts pass through the core. The armature winding consists of copper bars, laid in slots and insulated from the armature core by means of alternate layers of oiled linen and paper. The outside diameter of the armature is 10 ft. The commutator, consisting of hard drawn copper bars running parallel to the shaft, is supported on an extension of the armature spider in such a way as to entirely avoid any relative movement between the armature winding and the commutator segments.

The conductors are entirely on the surface of the armature, no copper extending along the inside of the armature core, but being connected on the back of the armature by means of soldered joints and in front by a copper rod extending from each conductor to a segment of the commutator. The current is collected by means of eight brass brushholders on each stud containing carbon brushes. An arrangement is provided by means of which the brushes may all be shifted at once to change the lead. These machines are guaranteed to carry a 25 per cent. overload for one hour and an overload of 40 per cent. temporarily without flashing or injurious sparking. The commercial efficiency at full load is 93.5 per cent.; at half load, 90.5 per cent.

In the new engine room the dynamos connected to the 2400-hp engines are each of 1600-kw capacity, one being located on the bed-plate of each engine, between the high and low pressure engines. The generator connected to engine numbered 8 runs at 100 revolutions per minute, is shunt wound, has an output of 5330 amperes at 300 volts

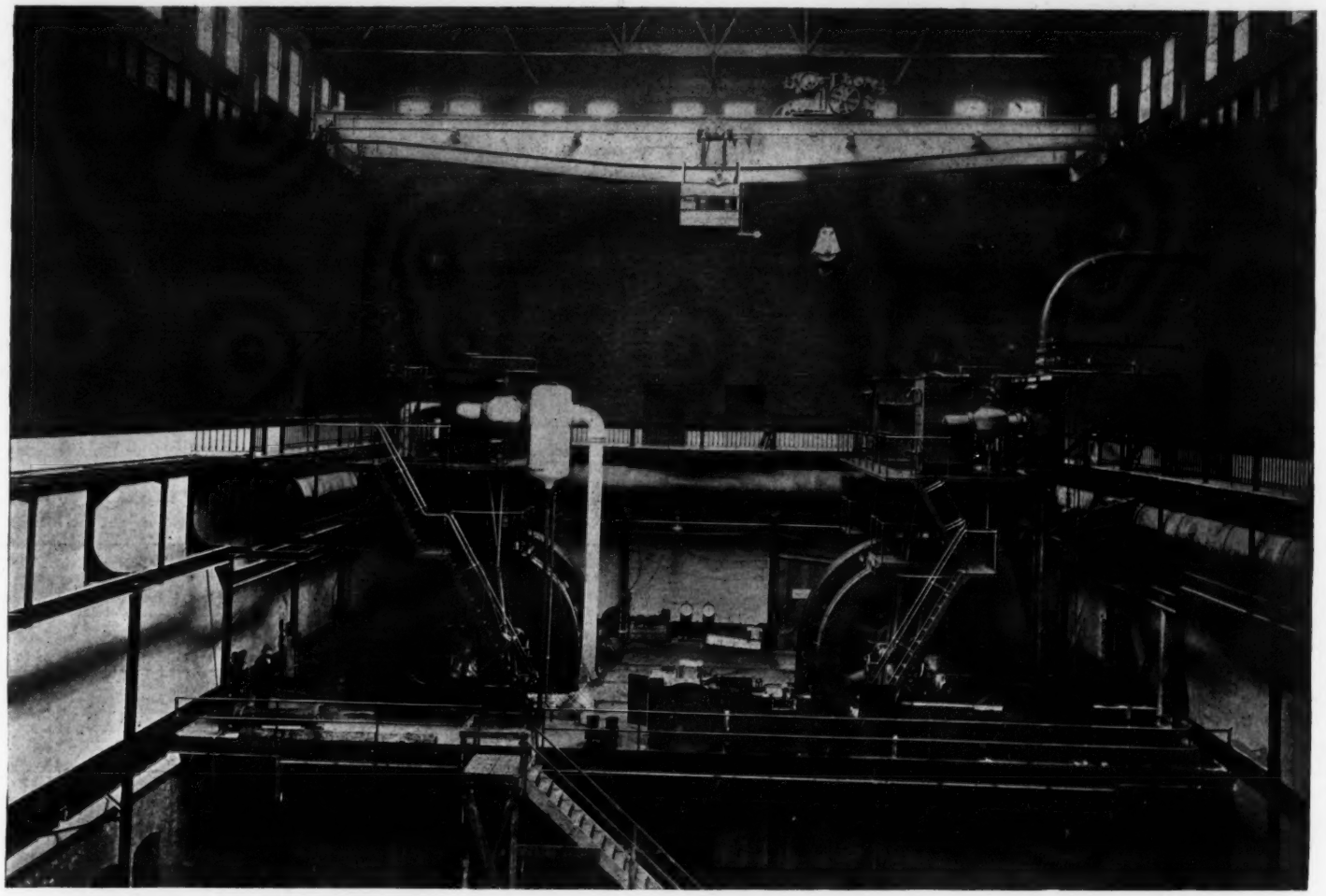


FIG. 44.—VIEW IN NEW ENGINE ROOM, ATLANTIC AVENUE.

or 5900 amperes at 270 volts, and has a circular magnet frame of high permeability cast iron, with 22 inwardly projecting poles having magnets connected in series. It is divided horizontally so that the upper half can be lifted up to provide for inspecting or removing the armature.

FIG. 45.—1600-KW ARMATURE IN PROCESS OF LAYING CONDUCTORS.

The pole pieces are made of cast steel and are fastened to the magnet yoke by bolts, so that any pole piece and field spool can be removed without disturbing the armature or magnet yoke. The weight of the complete machine is 190,000 lbs., that of the armature being 90,000 lbs. The armature spider is made of cast iron and is so designed that all shrinkage strains are avoided. The armature punchings or laminations are made from the best material, thoroughly annealed and securely keyed to the spider after having been thoroughly japanned to prevent eddy currents.

At certain intervals, space blocks are inserted between the laminations, providing ventilating ducts 3/8-inch wide for cooling the core and windings. Slots are punched in the periphery of the laminations to receive the armature conductors.

The armature conductors are made up of copper bars of high conductivity, adjacent ones being thoroughly insulated from each other. Conductors are bent on a form into the proper (hexagonal) shape so that they can be laid in the slots without difficulty and are interchangeable. The commutator, composed of hard-drawn copper bars, is supported on an extension of the armature spider and is keyed directly to the shaft, thus preventing any relative movement between the commutator segments and the armature conductors. Each conductor of the armature is connected to a segment of the commutator by a copper bar soldered at both ends. As there is no dead copper running on the under side of the armature, the conductors are connected by means of six copper bars running in parallel lines around the rear of the armature, to one of which every eighth conductor is connected in such a way that conductors of like potential and polarity are joined to the same copper bar.

The brushholders, eleven on each stud carrying carbon brushes, are so constructed that the tension on any brush can be adjusted without lifting the brush from the commutator and without the use of any tools. A threaded rod with a hand wheel is provided by which the lead of the brushes may be regulated by a man standing in front of the engine. The current is conducted from the collecting bars to the switchboard by means of a conductor made up of 12 heavy flexible cables. These generators have a commercial efficiency of 94 per cent at full load and 91 per cent at half load.

The dynamo opposite, on No. 9 engine, is very similar to the one just described, with the following exceptions: It is a double current machine, so wound as to furnish both direct and alternating current, the rated capacity being 5330 amperes at 300 volts direct current or 2500 amperes on each of six phases at 184 volts alternating current, or a proportional amount of either if both kinds of current are taken from the machine at the same time. It has 30 poles and runs at 100 revolutions per minute, giving a periodicity of 25 cycles per second. Besides the commutator on the direct current side, it has six collector rings on the opposite side of the armature with brushes and cables to conduct the alternating current to the switchboard. It is quite probable that the dynamos on the future engines will be driven driven and of greater capacity.

SWITCHBOARD ROOM.

In the southeast corner of the old engine room, as has been stated before, there is partitioned off a switchboard room, containing a feeder switchboard gallery, a regulating room and a motor operated switchboard. A photograph and drawings of this room are shown on another page. On the north side of the gallery is located a feeder switchboard, made of Knoxville marble, equipped with 5-way switches, connecting the feeders to one of the five different buses on each side of the system, running along the back of the board. The booster switches are also located on this board.

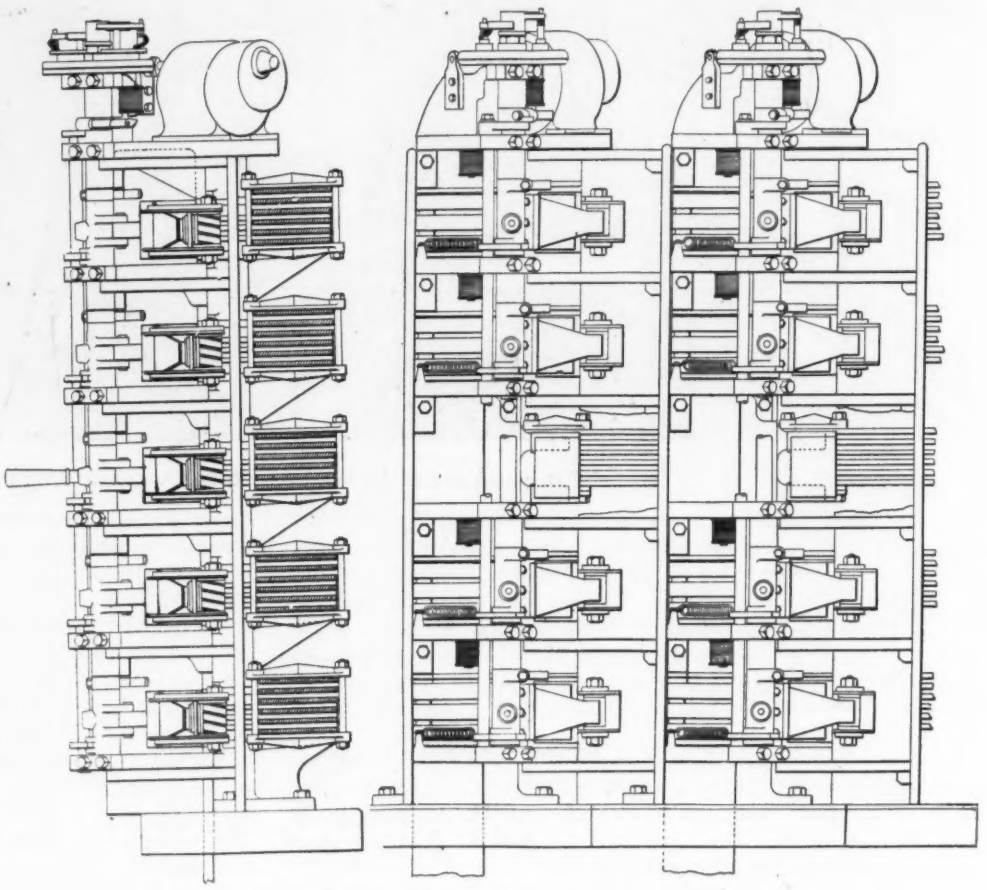


FIG. 46.—ELEVATION OF MOTOR CONTROLLED SWITCHES.

Above the switches are ammeters, of both the Weston and Thomson astatic types, in series with the feeders. Located at the end of this feeder board are four dial posts of the Cory system of engine telegraph, there being one for each engine room. Each set consists of one disk, signifying the engine or booster in question, the other denoting the instructions to be given regarding that unit.

On the opposite side of the room is another feeder switchboard, similarly equipped, containing also the battery switches. At the east end of the switchboard is the regulating platform, containing a board carrying all the main dynamo ammeters. A pressure wheel, having blocks connected to the pressure wires of all of the feeders, is so arranged that by moving the wheel around to a certain pressure block, the voltage on that feeder can be determined.

An ammeter connected in series with the station neutral wire shows how much the system is out of balance and which way. There are also installed here the battery neutral meters, Weston galvanometers for switching in the machines and other miscellaneous instruments.

Extending across the regulating platform are located the operating tables, upon which are located the control wheels for the dynamo field rheostats, also the apparatus for controlling the motor switches located on the floor below. Each switch is made up as follows: A copper post extends vertically along the length of the switch, through the floor, and is connected to the source of the current. Behind each row of switches are five bus-bars, to which are attached, one for each switch, five blocks of copper having their faces in line with the face of the copper post. There are mounted on a supporting pillar having a slate base, five copper pressure contact switches, which make connection between the copper post and the copper block on one of the bus-bars. The contact switch is made up of strips of copper, bent into the form of a hollow D, the ends making contact. These are each provided with an auxiliary circuit breaker and a magnetic blow-out. The whole switch is operated by a General Electric 2¼-hp, 115-volt motor, so arranged that by pressing a certain button at the operating table, the corresponding switch will be closed or opened as desired.

If one switch is operated while another on the same post is making contact, the latter switch will open automatically before the former one closes, so that no two switches on the same post can make contact with two bus-bars at the same time. There are 40 of these sets of switches, located 20 in a row along the length of the switchboard room, the positive switches thus being separated from the negatives. Each set of switches is enclosed in a neat box-like casing, made of Knoxville pink marble, a magnetic blow-out arrangement is so located as to drive the arc away from the switch towards the marble partition.

A certain number of these switches were designed to carry 7000 amperes for the larger dynamos and some of the tie-lines, while the rest are only required to carry 3500 amperes each. The buses at the rear of these switches carry the current directly to the feeder switchboards. There is a space provided on the other side of the room from these switches for a similar installation whenever it may be required.

FIG. 47.—SWITCHBOARD ROOM, ATLANTIC AVENUE, SHOWING SWITCH BOARDS AND MOTOR-OPERATED SWITCHES.

These motor controlled switches were designed by the General Electric Company especially for the Boston Edison Company, and are the first of the kind in existence. Although they may be considered somewhat of an experiment, there is no reason to believe that they will not perform in a satisfactory manner the work for which they were designed.

In the engine room, near the wall of the switchboard room, are located two three-wire General Electric booster sets, one being of 75-kw capacity, having six poles and running at a speed of 650 r. p. m. The motor end runs on 240 volts, while the booster end develops 1364 amperes at 55 volts. The other booster set has the same capacity, having four poles and running at 750 r. p. m., the motor

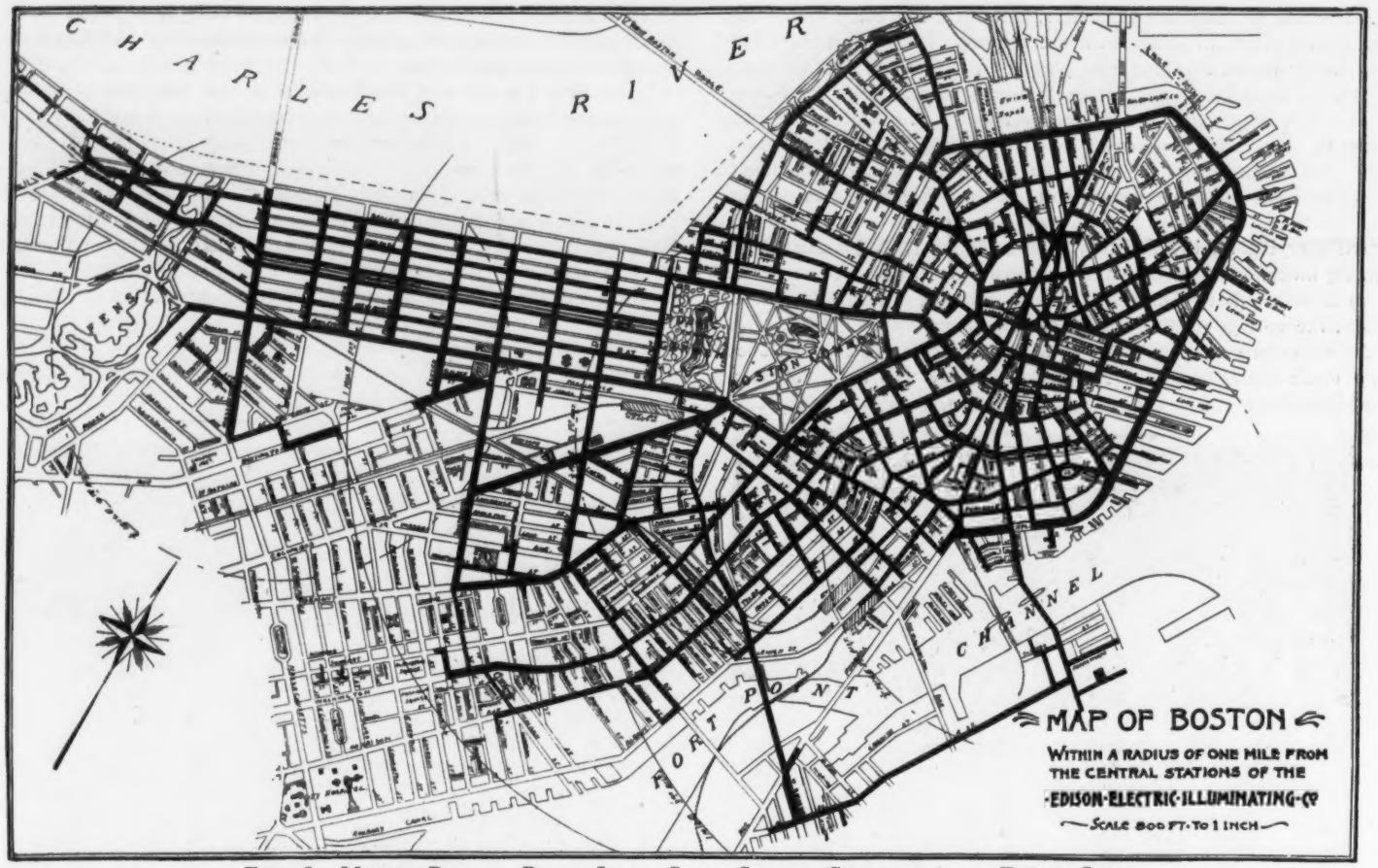

CHARLES RIVER
MAP OF BOSTON
WITHIN A RADIUS OF ONE MILE FROM THE CENTRAL STATIONS OF THE
EDISON ELECTRIC ILLUMINATING Co
SCALE 800 FT. TO 1 INCH
CHANNEL
FORT POINT

FIG. 48.—MAP OF BOSTON—BLACK LINES SHOW STREETS COVERED BY THE EDISON SYSTEM.

end running on 250 volts and the booster end supplying 1350 amperes at 55 volts.

DISTRIBUTION.

The current, after leaving the generators, is conducted by flexible cables through ammeters and switches to the bus-bars on the back of the feeder switchboard. Through the feeder switches the current is transmitted by the feeders through the feeder boxes to the junction

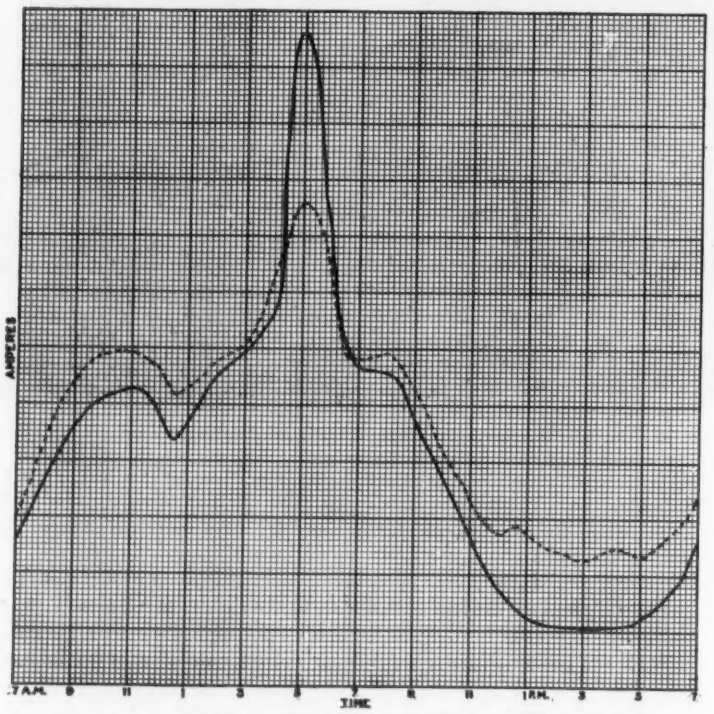


FIG. 49.—LOAD DIAGRAM—FULL LINE DENOTES AMPERES DISTRIBUTED; DOTTED LINE DENOTES AMPERES GENERATED.

boxes, from which the current passes to the mains. Services connect these mains with the customers' cutouts.

About fifty-three miles of street in Boston are covered by the underground system of the company, consisting of mains, feeders, feeder boxes, junction boxes, manholes, etc. There are 301,329 ft. of mains installed in the form of Edison 3-wire tube, the copper conductors varying in size from 200,000 to 350,000 circ. mils. There are installed, in the shape of feeders, 127,000 ft. of Edison three-wire, 1,000,000-cm tube, also 145,000 ft. of 1,000,000-cm cable and 35,000 ft. of 350,000 cm cable laid in conduit. Besides these, there are laid 17,000 ft. of Edison tube used for tie lines and 1000 ft. of 12-conduc-

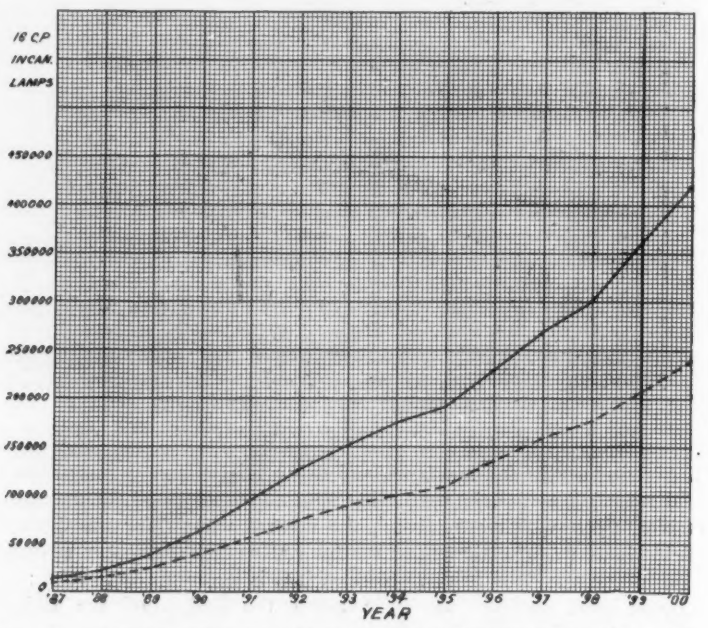


FIG. 50.—DIAGRAM SHOWING INCREASE OF LOAD CONNECTED—FULL LINE SHOWS TOTAL LOAD CONNECTED, IN TERMS OF 16-CP LAMPS; DOTTED LINE SHOWS TOTAL INCANDESCENT LAMPS IN 16-CP EQUIVALENTS.

tor and 63,000 ft. of 3-conductor pressure cable. The total length of Edison tube is 445,000 ft., that of the cable being 242,000 ft. A part of the cable in use has paper insulation, while the greater part of it is insulated with rubber.

The cable now in use by the company is of four different makes, as

follows: General Electric, Habirshaw, New York Safety and National Conduit & Cable. The cable is all drawn into conduits, varying in size from three to 120 ducts, and is laid in trenches 5 ft. to 14 ft. in depth. Two kinds of duct are in use, the cement lined furnished by the National Conduit & Cable Company, and the vitrified duct of the H. B. Camp Company, there being 80,000 single duct feet and 10,174 trench feet of the former and 371,000 single duct feet and 32,659 trench feet of the latter. There are also installed as a part

FIG. 51.—CABLE MANHOLES JOINING DUCTS LEADING FROM ATLANTIC AVENUE STATION.

of the system 18 Edison tube feeder boxes, 393 Edison junction boxes with a total of 185 manholes.

The current is measured on the customers' premises by means of Edison chemical meters, and T.-H. recording meters. The well-known Wright demand meter, which has been described sufficiently heretofore, is also used quite extensively on the system to indicate the maximum amount of current consumed at any one time.

Edison incandescent lamps are used on the system and are furnished and renewed without expense to the customer, there being connected to the company's mains 243,800 16-cp lamps, or their equivalent. There are also connected to the incandescent circuit 2429 arc lamps, most of these being Jandus enclosed arcs of the 150-hour type. The motors on the system vary in size from 1-16-hp to 100-hp, with an aggregate of 10,400 hp.

FIG. 52.—A CABLE JUNCTION BOX.

The current is generated principally from the Atlantic Avenue station, the plants at stations numbered 1 and 2 begin operated only during the periods of heavy load in the winter, or when the tie lines would otherwise be overloaded.

The current is distributed to the sub-stations by means of tie lines, there being six sets running to the first station, two to the second, and one to the sixth, while from the first station there are two connecting to the fourth station, and one to the fifth station. The current from the Atlantic Avenue station proceeding over the tie lines is carried in each case to the bus-bars on the feeder switchboard, and is used to supply the demands of the customers and also to charge the storage batteries.

There will be found on another page a representative daily load diagram (Fig. 49) showing in full line the distributed amperes on the whole system, the broken line representing the total generated load. It will be observed that the maximum load occurs at about 5 p. m., at which time the curve of distributed amperes towers above the generated curve, the storage batteries supplying the difference of load. On either side of this peak are positions where the generated curve surmounts the distributed. At such times the batteries are being charged from the system.

About 48 per cent of the current generated at the Atlantic Avenue station is distributed for lighting and power in that district, about 40 per cent is sent over the tie lines to the sub-stations having an auxiliary steam plant, and about 12 per cent goes to the battery sub-stations for supplying customers in those districts and for charging the batteries.

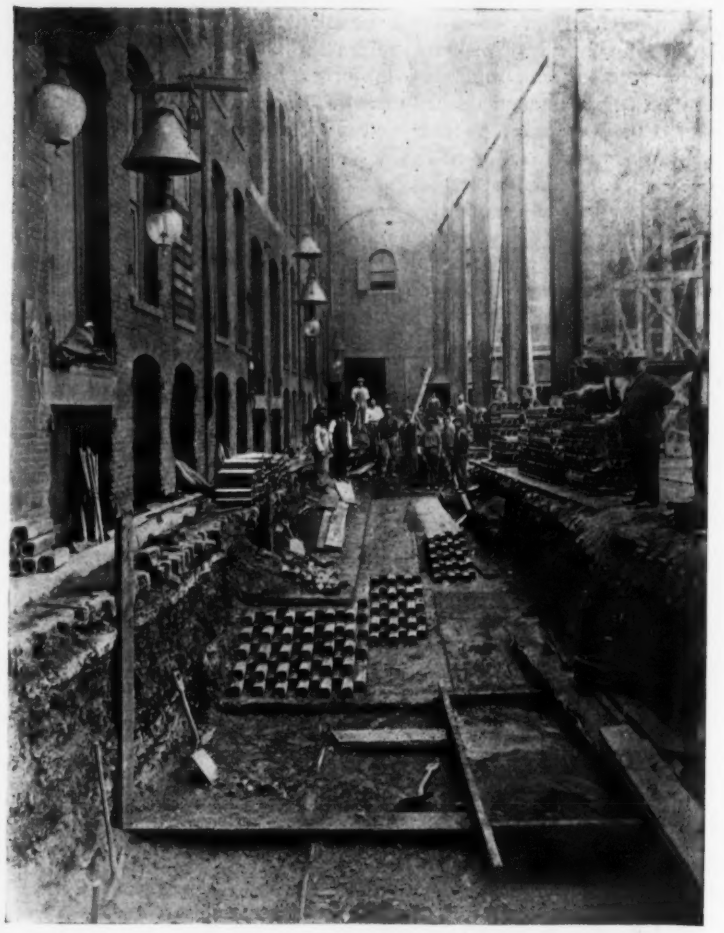


FIG. 53.—CONDUIT IN ALLEY LEADING TO THIRD DISTRICT STATION, ATLANTIC STATION.

Negotiations are under way for the purchase of the Boston Electric Light Company by the Edison Company, and when these plans have been fully consummated and the two systems have been put upon a revised basis of operation, it is probable that that part of the commercial lighting and power of the Boston Company which is included in the Edison districts will be supplied from the Atlantic Avenue station, the reserve power thus relieved at the Boston Company's station being used to operate through motor generators the sub-stations of the Edison Company heretofore supplied from the Atlantic Avenue plant.

OTHER BUILDINGS.

Besides the buildings already referred to, at 1 and 2 Head Place, next to the first station, is a four-story brick building, the first floor and basement of which are used as exhibition rooms where there are examples of many of the different kinds of machines and apparatus operated by electricity which have been loaned by the manufacturers,

and are exhibited by the company. The second and third floors of the building contain the storage battery which has already been referred to.

The fourth floor of the building is fitted up as a hall, which is used for meetings and conferences, and by the Edison Employees' Club for lectures and entertainments.

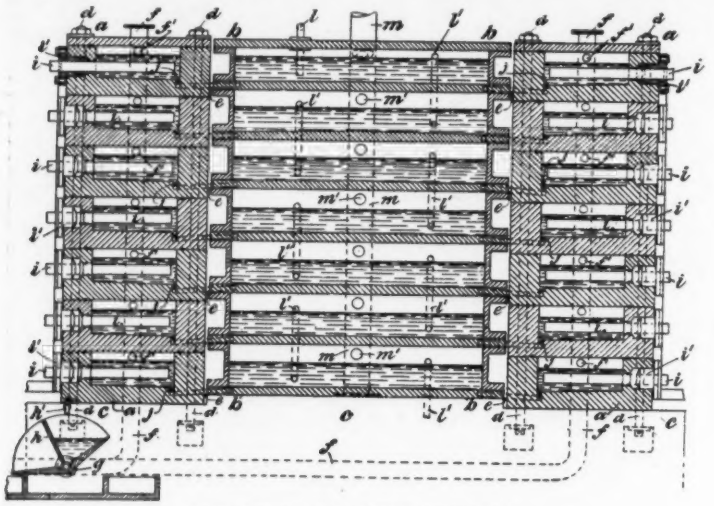
At 516 Atlantic Avenue, next to the new station, is the System of Distribution Building, seven stories high, and made entirely of brick. The offices of the distribution and generating departments are located in this building, as is also the draughting room. Two of the floors are occupied by storage batteries, and the lamp department and stockroom occupy other floors of the building.

On the fifth floor of the building is a testing laboratory fully equipped with the latest and most delicate apparatus. Here are kept the company standards for calibrating instruments to be used in measuring current. Here the insulation of cables may be tested, new or proposed apparatus investigated, and general laboratory work done in connection with the business of the company.

A Novel Electrolytic Cell.

In the electrolytic production of alkali and chlorine in the well-known Castner type of cell, sodium set free by the electrolysis of sodium chloride in solution is absorbed by a cathode of mercury; the resulting amalgam must then be brought into the presence of water to oxdize the sodium to caustic soda, and the regenerated mercury must be returned to the field of the current. The problem of the most effective accomplishment of this result, apparently so simple, is in reality greatly complicated by three factors, namely, the tendency of the separated sodium to react upon the electrolyte, which limits the percentage which may be profitably absorbed in the mercury; the relative slowness with which the amalgam reacts with water to produce caustic; and the tendency of the mercury itself to oxidize if too far denuded of its alkali metal.

One of the most ingenious cells of this form is the subject of a patent recently issued to George and George W. Bell, of Liverpool, England. This cell is destitue of moving parts, and the transfer



NEW FORM OF ELECTROLYTIC CELL.

of the charged mercury is effected by varying the pressure upon its surface, whereby it is alternately forced into the presence of water and permitted to return to its normal position beneath the anodes. The absence of moving elements permits a compactness and closeness of organization which is well illustrated by the accompanying figure, showing a section through a battery of 14 cells. The electrolyzing cells *a*, are arranged in two tiers, flanking the oxidizing compartments, *b*, and connected with them by conduits, *e*, joining their basal portions. Each cell is provided with a horizontal series of carbon rods, *i*, passing through stuffing boxes i^1, and constituting the anodes. The cathode is a layer of mercury covering the bottom of each decomposing compartment, electrical connection therewith being made through the amalgamated metal bars *j*. The oxidizing cells wherein the amalgam is partially denuded of its sodium, are, as shown, placed adjacent to and slightly above the electrolyzers, with their bottom plates inclined slightly toward the conduits *e*, on either side. The caustic solution circulates through the intermediate chambers by means of the pipes *l*, l^1, and a manifold *m*, m^1, is provided for education of the liberated hydrogen. As appears in the figure, a single valve, *g*, intermittently operated by a tumbling box *h*, controls the outflow of chlorine from all of the seven decomposing cells constituting one tier; a similar valve upon the same rock-shaft controls the gas discharge from the other set of cells, the two valves being so arranged that the throw of the shaft which closes one opens the other.

Let us suppose the chambers, *a a*, to be filled with a saturated solution of sodium chloride, the intermediate cells *b* with water, the mercury cathode to be in place covering the bottom of the electrolyzers and filling the conduits *e*, and one of the valves *g* closed. Upon the passage of the current sodium is liberated and dissolved by the mercury, while chlorine accumulates above the electrolyte, and as the pressure due to the chlorine rises the mercury is forced through the channels *e* into contact with the water in the central cells. This continues until all of the mercury has passed from the electrolyzers, whereupon electrolytic action practically ceases, owing to the reduction of the cathode area, an essential feature, since continued pressure would break the mercury seal between the chloride and caustic solutions. At this point the tumbler-box, operated by the flow of water from the cock h^1, shifts the valves, the mercury returns by gravity to the set of electrolyzers from which it had been discharged, and the operation begins for the opposite series. The electrolyzers are supplied with sodium chloride solution through a system of pipes whose flow is governed by the same rock-shaft which controls the gas pressure, and hence the entire operation of the battery of 14 cells is regulated by the stream of water from the cock h^1, a remarkable example of ingenious simplicity.

The inventors describe other means for accomplishing the same results, intermittently operating electromagnetic devices whereby the flow of chlorine may be governed, or the hydrostatic head of electrolyte or of caustic solution varied in such manner as to cause the alternating flux and afflux of the mercury; and electric motor-meters adapted to shift the valves after a definite and predetermined quantity of current has traversed the electrolyte. The cell, however operated, is, of course, subject to the disadvantages inherent in the mercury cathode type, but within its limitations it should prove highly efficient.

A Simple Diagram Showing the Regulation of a Transmission System for any Load and any Power Factor.

By F. G. Baum.

At the last annual meeting of the American Institute of Electrical Engineers, Dr. F. A. C. Perrine, in conjunction with the writer, gave a method for calculating the regulation of transmission lines.[1] A simple diagram results from the equation developed in the article mentioned, which gives the pressure at terminals of generator for any load and any power factor with but a single calculation. For any transmission line let

E_0 = e. m. f. at terminals of generator,
E = e. m. f. at terminals of receiver,
R_1 = equivalent resistance[2] of step-down transformers,
R_2 = equivalent resistance of step-up transformers,
L_2w = equivalent inductance of step-up transformers,
L_1w = equivalent inductance of step-down transformers,
R = resistance of line,
Lw = inductance of line.

Also let

$$L_t\, w = (L_1 + L_2 + L)\, w$$
$$R_t = R_1 + R_2 + R$$
I_c = capacity current of line.
$I \cos \Theta$ = energy component of load current.
$jI \sin \Theta$ = wattless component of load current

It was shown in the article referred to that the e. m. f. at terminals of generator is given by the equation:

$$E_0 = E + I\cos\theta\,(R_t + j\,L_t\,w) - j\,I\sin\theta\,(R_t + j\,L_t\,w) + {}^{j}I_c\left[\left(R_2 + \frac{R}{2}\right) + j\left(L_2 + \frac{L}{2}\right) w\right] \quad (1)$$

This equation expresses in complex quantities the fact that each com-

[1] The use of aluminum line wire and some constants for transmission lines. By F. A. C. Perrine and F. G. Baum, Trans. A. I. E. E., Vol. XVII. p. 391.

[2] It is customary to convert all pressures to equivalent line pressure. If R is the resistance of the primary of the transformer, and r is the resistance of the secondary, the equivalent resistance is calculated by the formula $R_1 = R + a^2 r$, a being the ratio of transformation. The equivalent inductance Lw is determined from the resistance drop in the transformer and the short circuited regulation.

ponent of the line current may be considered as separately flowing over the entire line, and the capacity current over one-half the line and the step-up transformers. (Since positive rotation is taken as counter-clockwise, the impedance in complex quantities of a coil having resistance and self-induction is properly written $R + j\,L\,w$. Quantities multiplied by $+j$ are then laid off above and quantities multiplied by $-j$ below the zero line.)

Let us take, first, a line 15 miles in length. Here the charging current may be neglected, since it will only be about 2/3 ampere at 10,000 volts. This reduces equation (1) to

$$E_0 = E + I\cos\theta\,(R_t + j\,L_t\,w) - j\,I\sin\theta\,(R_t + j\,L_t\,w). \qquad (2)$$

Since in transmission usually a three-phase star connection is used such a line will be assumed in this paper (a single or two-phase system may also be worked out in the same way). In making calculations on three-phase systems it simplifies the problem to consider one leg only. If $E\sqrt{3}$ is the voltage between line wires we consider one leg of the system with a voltage E applied to one line wire and the neutral, the latter having no resistance or inductance. This corresponds to a balanced load on a three-phase system.

First case (Fig. 1.):

Length of line	15 miles
Power delivered	3000 kw (1000 per leg)
Voltage delivered (between neutral and outside)	10,000
Frequency	60 cycles
Distance between wires (wires on corners of triangle)	30 inches
Resistance of line	6 ohms
Inductance of line	10 ohms
$R_1 = R_2$	1 ohm
$L_1 w = L_2 w$	5 ohms

From the above we get

$$R_t = 8 \text{ ohms.}$$
$$L_t\,w = 20 \text{ ohms.}$$

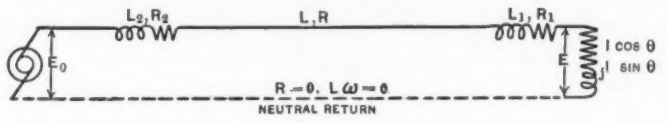


FIG. 1A.

(The constants assumed gives 8 per cent I^2R loss at full load in the transmission from the terminals of generator to terminals of receiver.)

Current delivered with $\cos\theta = 1$ is 100 amperes. Hence we have for triangle *abc*, Fig. 1,

$$ab = R_t\,100 = 800 \text{ volts},$$
$$bc = (L_t\,w)\,100 = 2000 \text{ volts},$$
$$\therefore ac = 100\,(R_t + j\,L_t\,w) = 2200 \text{ volts}.$$

For any power factor, $\cos\theta$, lengths along *ac* are equal to $I\,(R_t + j\,L_t\,w)\cos\theta$; i. e., proportioned to load at constant receiver pressure, since $I\cos\theta$ is proportional to load and $(R_t + j\,L_t\,w)$ is a constant.

Let *Oa* represent 10,000 volts delivered to receiver. We are to determine the generator pressure for any condition of load. The triangle *abc* gives the voltage drop over the line with a non-inductive full-load. *Oc* will, therefore, give E_0 for non-inductive full-load. Draw *cg*, making an angle θ equal to, say, 43 degs. 30 min., with *ac* corresponding to $\cos\theta = .725$. From *c* draw a line at right angles to *ac* and produce it until it meets *cg* in *g*. Then, since

$$ac = I\cos\theta\,(R_t + j\,L_t\,w) \text{ and angle } acg = \Theta$$
$$\therefore cg = I\sin\theta\,(R_t + j\,L_t\,w)$$

by construction. That is *Og* represents E_0 for full load for a power factor of 0.725. Since the receiver pressure is to be maintained constant, *ac* will always represent the same load whatever the power factor. Lengths from *a* along *ac* are proportional to load. Divide *ac* into, say, 10 equal parts, corresponding to 0.1, 0.2, 0.3, etc., of full load. Through points marked 0.1, 0.2, 0.3, etc., draw lines at right angles to *ac*. From *a* draw radial lines, making angles with *ac* corresponding to $\cos\theta = .95$, $\cos\theta = .90$, etc., for leading and laging current. With *O* as center and 10,000, 10,200, 10,400, etc., as radii, draw arcs of circles as shown. The radial distance between two successive circles represents 2 per cent of delivered voltage.

To illustrate the use of the diagram suppose we wish to find the generator pressure for 0.9 of full load, delivered at 0.8 power factor. Follow the line *ac* up to *c'*, then go along the line *c'g'* to the intersection of *c'g'* with the line corresponding to $\cos\theta = 0.8$. This point is seen to represent a voltage of 12,150, or the generator voltage must be 21.5 per cent above the receiver voltage. In a similar manner the generator pressure may be found for any other load at any power factor for lagging or leading current. If the current leads the desired point is given by the intersection of *c'g*, and line marked $\cos = 0.8$.

In constructing the diagram for any particular transmission line, it is only necessary to determine *ab* and *bc;* the remainder of the construction is mechanical.

Second case:

We may apply the same method to the case of a long line, a line 150 miles in length being assumed. For this case we use equation (1), first given.

Power delivered	9000 kw (3000 kw per leg)
Length of line	150 miles
Voltage delivered (between neutral and outside wire)	30,000
Frequency	60 cycles

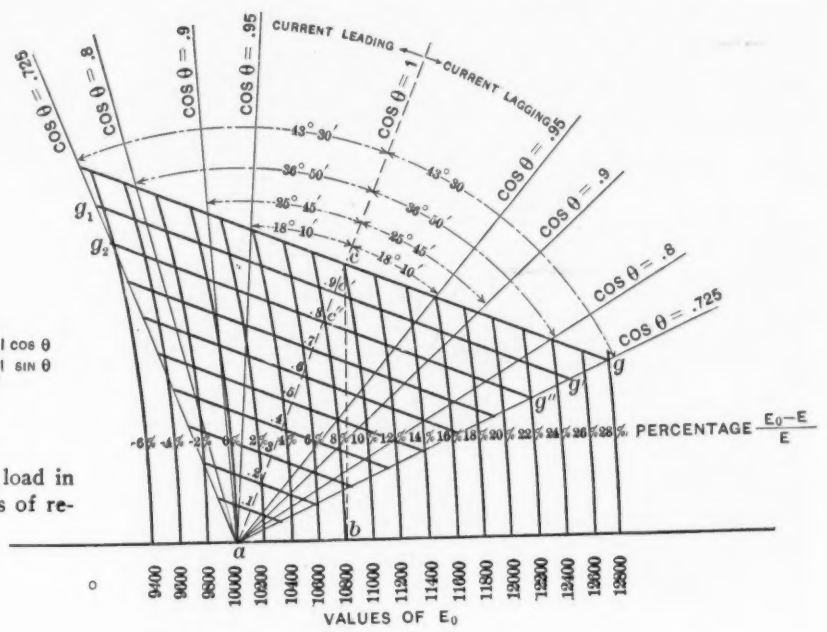


FIG. I.—DIAGRAM FOR CALCULATING TRANSMISSION LINES

Distance between wires (wires on corners of triangle)	40 inches
Resistance of line	26 ohms
Inductance of line	106 ohms
R_1	2 ohms
R_2	2 ohms
$L_1 w$	15 ohms
$L_2 w$	15 ohms

Capacity current per wire is 40 amperes (the charging current will be about 35 amperes at light load).

From the above we get

$$R_t = 30 \text{ ohms},$$
$$L_t\,w = 136 \text{ ohms},$$
$$R_2 + \frac{R}{2} = 15 \text{ ohms}.$$
$$\left(L_2 + \frac{L}{2}\right) w = 68 \text{ ohms}.$$

(The constants assumed above give an efficiency of transmission of about 88 per cent at full load).

Current delivered per wire is 100 amperes with $\cos\theta = 1$.

Hence we have for the triangle *abc*, Fig. 2:

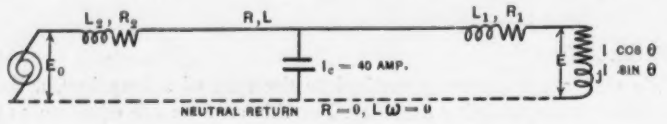
$$ab = (R_t)\ 100 = 3000 \text{ volts},$$
$$bc = (L_t\ w)\ 100 = 13600 \text{ volts},$$
$$\therefore ac = 100\ (R_t + j\ L_t\ w) = 13800 \text{ volts}.$$

And for the triangle *kla*

$$kl = \left(R_2 + \frac{R}{2}\right) I_c = 600 \text{ volts},$$

$$la = \left(L_2 + \frac{L}{2}\right) w\ I_c = 2720 \text{ volts}.$$

Fig. 2 is similar to Fig. 1, except for the triangle *kla*. To find E_0 for 0.8 full-load at a power factor of 0.8, follow *ac* up to the letter *c"*, then along *c"g"* to the intersection with the line corresponding to



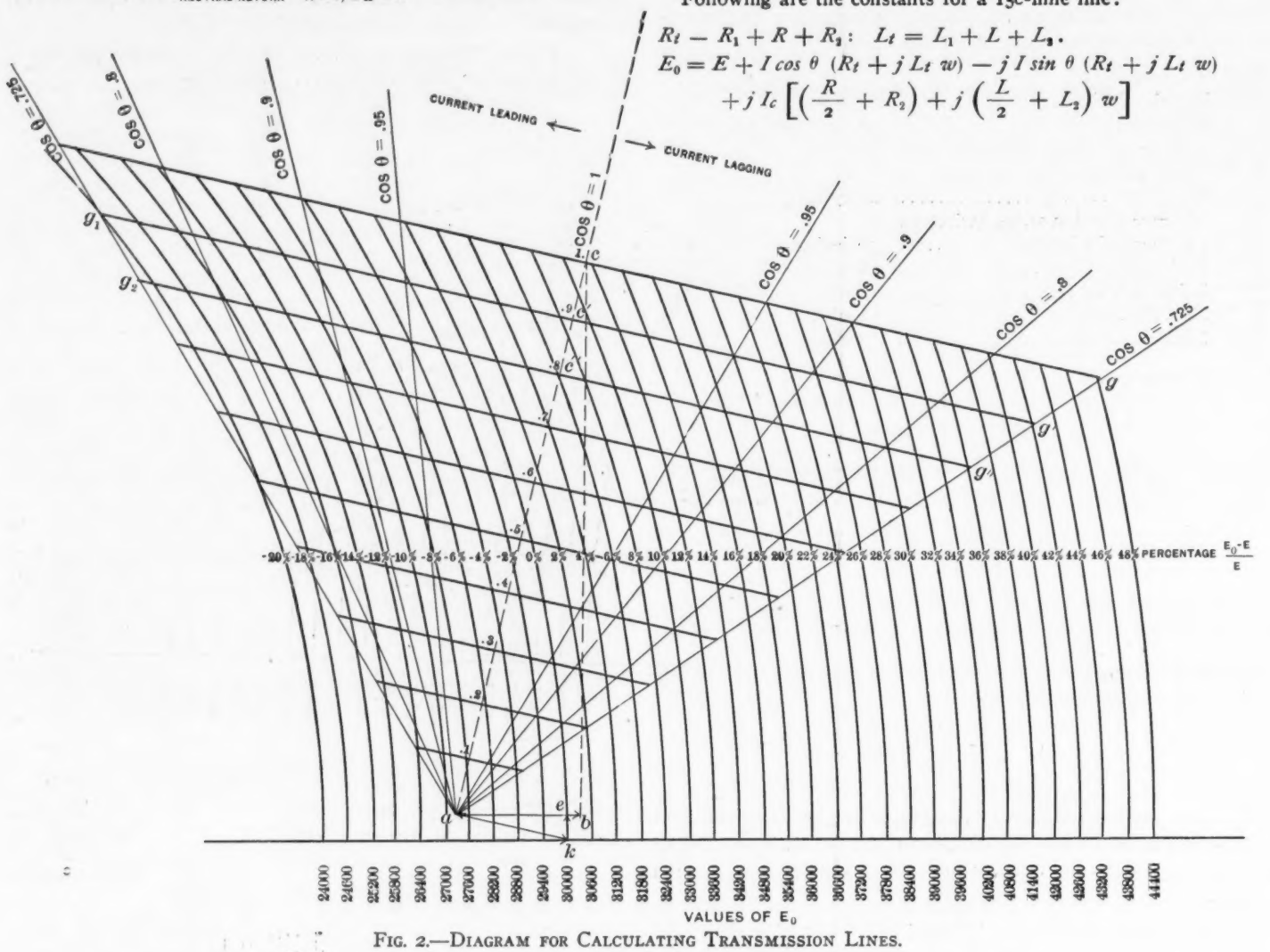


FIG. 2.—DIAGRAM FOR CALCULATING TRANSMISSION LINES.

cos $\theta = 0.8$. The value of E_0 is seen to be 39,000 volts. That is, the pressure at the terminals of the generator must be increased 30 per cent. At some point in the system, therefore, this amount of regulation must be allowed.

As shown by the point *a*, the generator pressure for 30,000 volts delivered with no load on receiver will be 27,300. There is, therefore, a rise in pressure at no load between the generator terminals and the receiver equal to 2700 volts, or 9 per cent.

It will be found that the diagram given will very much lessen the labor of making calculations for transmission lines. For each particular case the triangle *abc* must be constructed, the remainder of the diagram is drawn mechanically.

Following are the constants for a 15-mile line:

$R_t = R_1 + R + R_2$, $L_t = L_1 + L + L_2$

$E_0 = E + I\ cos\ \theta\ (R_t + j\ L_t\ w) - j\ I\ sin\ \theta\ (R_t + j\ L_t\ w)$.

$Oa = E$

$ab = I\ R_t$

$bc = + j\ I\ L_t\ w$

$cg = I\ sin\ \theta\ (R_t + j\ L_t\ w)$.

Constants: $R_2 = R_1 = 1$ ohm, $R = 6$ ohms; $L_2\ w = L_1\ w = 5$ ohms, $L\ w = 10$ ohms.

K. W. deliv. = 3000; voltage deliv. = 10,000 (Bel. neutral and line wire).

Eff. of transmission at non-inductive load = 92 per cent.

As an example, find *Eo* for 0.8 load at 0.725 power-factor. Follow *ac* to point *c"* (marked .8), then follow *c"g"* to point of intersection of *c"g"* with line marked $cos\ \theta = 0.725$. The point is on the circle 12,200. This is the value of *Eo* (22 per cent above *E*). (Lagging current assumed in example, for leading current *Eo* is given by *pt.* g_2).

Following are the constants for a 150-mile line:

$R_t = R_1 + R + R_2$: $L_t = L_1 + L + L_2$.

$E_0 = E + I\ cos\ \theta\ (R_t + j\ L_t\ w) - j\ I\ sin\ \theta\ (R_t + j\ L_t\ w)$
$+ j\ I_c \left[\left(\frac{R}{2} + R_2\right) + j\left(\frac{L}{2} + L_2\right) w\right]$

Constants: $R_2 = R_1 = 20$ ohms; $R = 26$ ohms.

$L_2 w = L_1 w = 15$ ohms; $Lw = 106$ ohms.

K. W. delivered = 9000.

Voltage delivered = 30,000 (bet. neutral and outside wire) = *ok.*

$Kl = + j\ I\ c \left(\frac{R}{2} + R_2\right)$; $la = - I\ c \left(\frac{L\ w}{2} + L_2\ w\right)$;

$ac = I\ cos\ \theta\ (R_t + j\ L_t\ w)$ is prop. to load on receiver.

$cg = I\ sin\ \theta\ (R_t + L_t\ w)$.

Eff. of transmission at non-ind. full-load = 88 per cent (about).

As an example, to find *Eo* for 0.8 load at 0.8 power-factor. Follow *ac* to point *c"* (marked .8), then follow *c"g"* to point of intersection of *c"g"* with line marked $cos\ \theta = 0.8$. The point is on the circle 39,000. This is the value of *Eo* (30 per cent above *E*). (Lagging cur, assumed in example; for leading cur, *Eo* is on *c"* g_2 and *cos* $\theta = .8$).

Telephone Line Construction on the Pacific Coast.

THE line construction on the Pacific Coast of the Pacific States Telephone Company is modified by the fact that sleet is unknown. Hence pole lines can safely be loaded with a much greater number of wires than would otherwise be safe. Another peculiar practice of this company is that of using porcelain insulators altogether for local city and suburban lines. Pole lines with porcelain insulators present a very neat appearance when constructed as well as is the custom of this company. Figs. 1, 2, 3 and 4 give a good idea of the main features of the work in various cities. The longest cross arms for city and suburban lines carry 20 porcelain insulators on top of the cross arm and one on each end, making 22 in all. The cross arms are of Oregon pine, 10 ft. long. For long-distance work, as shown on the top of the pole (Fig. 1) 10 pins with glass insulators are put on a cross arm 10 ft. long. The local line cross arms in Fig. 1 are not full length. Fig. 2 shows a pole line of about the maximum line carrying capacity used, which has 176 wires on 8 cross arms, besides a cable and some few wires on the lowest arm. No. 14 galvanized iron wire is used on city and suburban lines. On long-distance lines, hard-drawn copper weighing 435 lbs. to the mile, No. 8 B. W. G. (about No. 6 B. & S.) is the standard Aluminum has been used to some extent on long-distance lines recently. There is one line of this kind from Bakersfield to Los Angeles, and one from Sacramento, Calif., to Reno, Nev. The aluminum con-

FIG. 1.—POLE LINE WITH LONG-DISTANCE AND LOCAL WIRES, SAN JOSE.

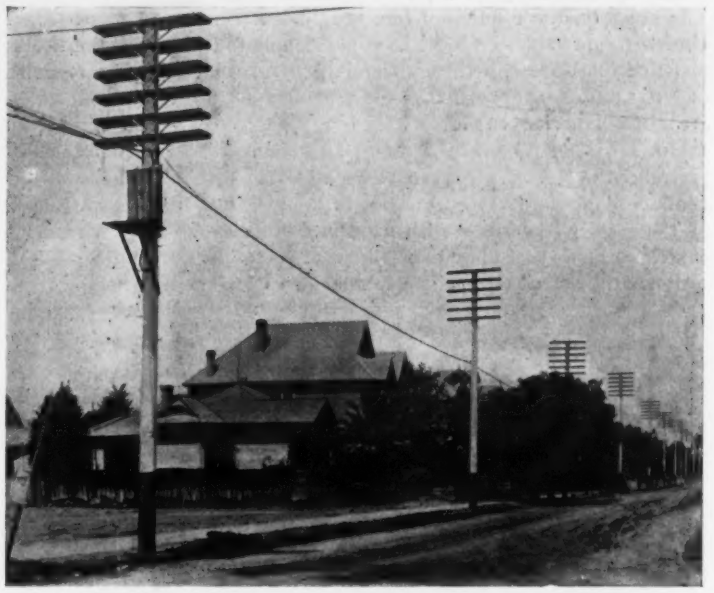


FIG. 3.—POLE LEAD, PICO AND MAIN STREETS, LOS ANGELES.

FIG. 4.—POLE LINE, PACIFIC AVENUE, TACOMA.

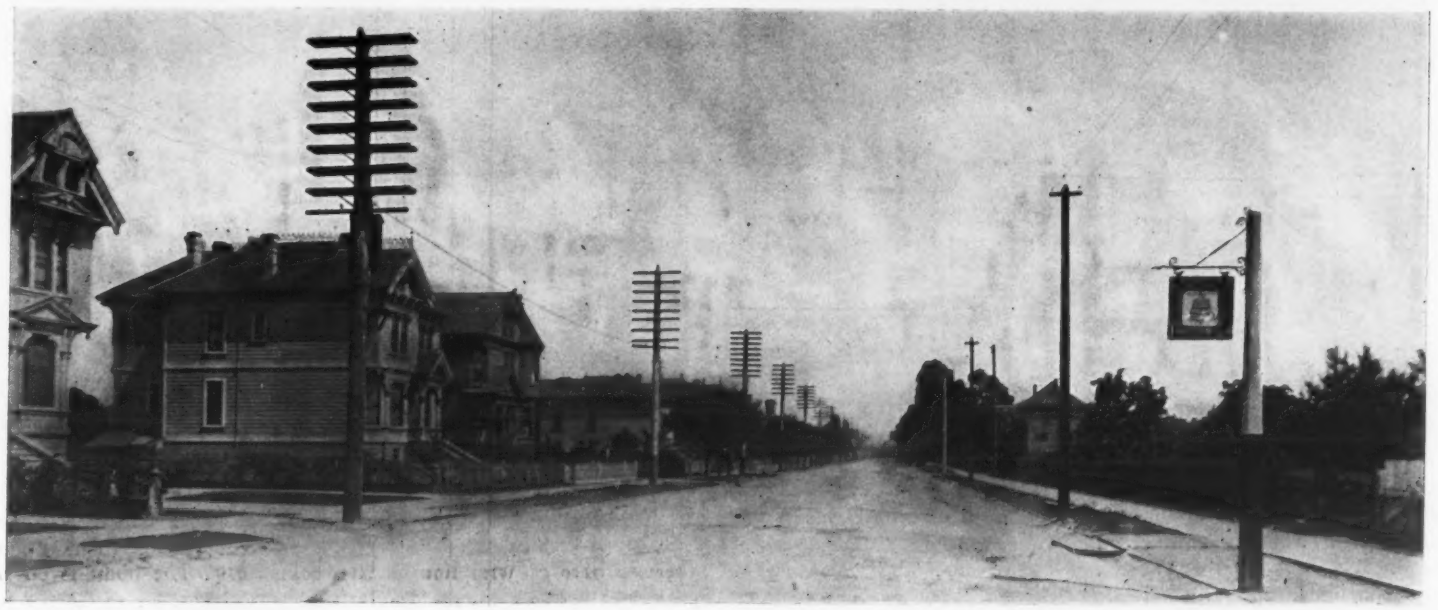


FIG. 2.—POLE LEAD, CENTRAL AVENUE, ALAMEDA.

ductor is in the shape of a 7-strand cable, weighing 210 lbs. per mile. The poles on the aluminum line are placed from 36 to 40 per mile. Underground cables on local lines have 40 pairs of No. 16 wire. Long distance lines are run through underground cables, having 10 pairs of No. 14 wire. Between Oakland and San Francisco, under the bay, are six submarine cables, containing 7 pairs each. No submarine cables are used larger than this. The conductors are composed of 7 strands of No. 20 copper wire on all recent cables. The stranded conductor is found vastly superior to the solid for this class of work, as the solid wires break with handling and disable many wires in a cable. A history of all cables is kept at the office showing their conditions at different tests. The submarine cables running north across

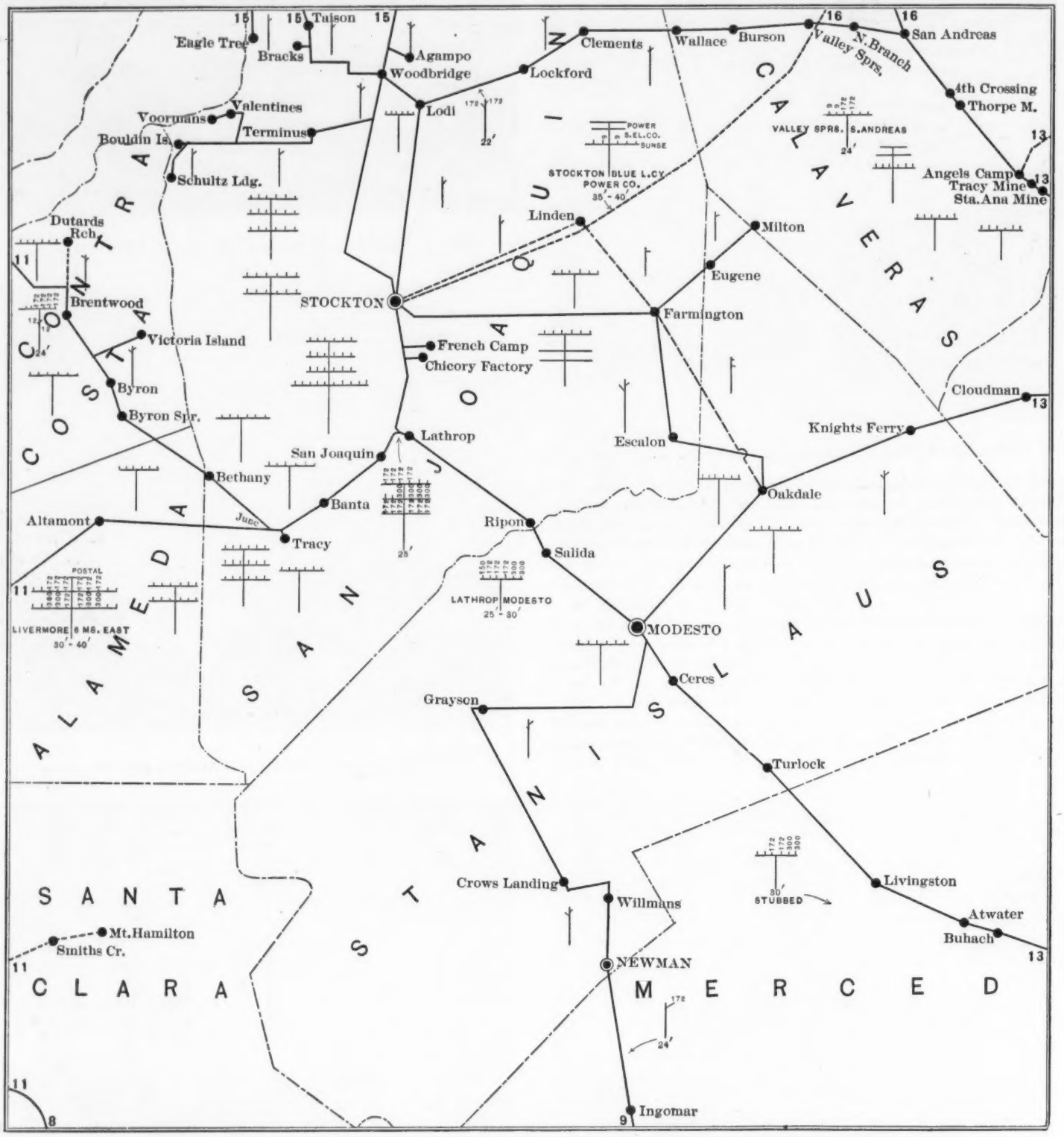


FIG. 5.—METHOD OF SHOWING LINES. (SOME POLES NOT SHOWN FULLY IN THE REPRODUCTION.)

originated on the Pacific Coast, and is now manufactured in Chicago. It is said that lead-covered cables under similar conditions to those in vitrified clay ducts show practically no electrolysis, while those in some clay ducts are badly pitted. The "electrolysis-proof" conduit is a tough paper tubing treated with a compound. About 1,000,000 ft. of this conduit is now down. The joints between pipes are made by driving the ends of the pipe together, the ends being arranged for a male and female joint with 1-inch countersink. The joint is dipped in the compound used in making the pipe. The joint so made is very tight. In fact, the pipe has been used in some cases for water pipe. It is made in 7-ft. lengths.

The engineer's office keeps track of long distance and toll lines in the company's territory by means of sectional maps. The map of the territory is divided up into sections, and a detail map of each section kept. One of these sections is shown in Fig. 5. The details of the pole lines between towns is indicated by diagrams on the map. A miniature pole is shown, and the number of wires and weight of each wire in pounds per mile can be seen at a glance. The height of the pole is shown by the figures at the base.

the Golden Gate are all double armored. Those to Oakland are single armored. An interesting experiment has been tried at Portland. A 75-pair paper insulated and lead-covered cable was armored and run under the Willamette River as a submarine cable. So far the experiment has been a success. No 4 wire was used in the armor.

On underground work in San Francisco great success has been obtained with "electrolysis-proof" conduit duct, a production which

STATUARY AROUND THE ELECTRIC TOWER, PAN-AMERICAN EXPOSITION.

The Pan-American Exposition.

The one striking feature of the Pan-American Exposition which will make it live in the memory of all who are fortunate enough to see it, and which will undoubtedly be recognized as the most emblematical feature of the Exposition, is the Electric Tower, some idea of which may be obtained from the illustration shown herewith. On entering the grounds, the Electric Tower, 400 ft. high, stands out prominently above everything, and although it is not yet completed and much of its beauty is still to be developed, it is already the center of attraction at the Exposition by day and night, and nothing but praise is heard concerning it, more especially when it is illuminated. It is then that the full beauty of the tower is brought out, the even distribution of light giving it the appearance of being transparent.

FIG. 1.—ELECTRIC TOWER ILLUMINATED.

Five hundred thousand gallons of water per hour will pour forth in a cascade into the upper basin, which will be filled with lights and will run down into the huge lower basin in which are arranged 100 powerful searchlights, which will focus upon the cascade.

The general scheme of lighting the Exposition is so perfect that no glare of light strikes the observer, although the illumination is so bright that it may be seen for miles around. It is when seen at a distance that the care and skill employed in working out this lighting scheme are fully appreciated, the various cupolas, minarets, etc., being subordinated to the Electric Tower, while the absence of arc lamps from the grounds gives the observer the full benefit of the beautiful details of the various buildings picked out in the soft and even diffused light of the incandescent lamps.

Probably another feature which will impress every visitor to the grounds is the unique way in which the electric tower is lighted. The current is brought in from Niagara and is controlled by a water rheostat, which enables the engineers to illuminate the tower and buildings gradually, so that one first sees a dark, dull, red outline of the Tower starting up in the sky, following with a brighter red and then a golden hue, until finally turning to the brightness of the full candle-power of the lamps used. The effect has been compared to that of a beautiful woman unveiling, and is attracting the attention of every visitor to Buffalo. We illustrate herewith the Electric Tower at night and the Music Hall, both photographed by their own light. Details of the Electric Tower and of the Electric Fountains were given in our issue of May 4.

The names of exhibitors in the Electricity Building correspond to the numbers on the floor plan (page 828): Section "A."—1, Niagara Falls Transformer Plant; 2, General Electric Company.

Section "B."—1, Morris Electric Company; 2, H. B. Camp Company; 3, Bossert Electric Construction Company; 4, National Carbon Company; 5, American Vitrified Conduit Company; 6, Peru Electric Manufacturing Company; 7, McGraw Publishing Company; 8, The O. C. White Company.

Section "C."—1, General Electric Company.

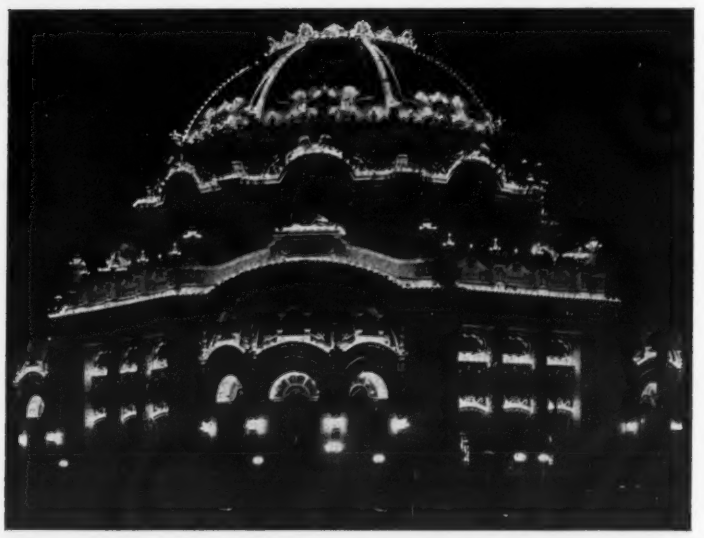


FIG. 2.—TEMPLE OF MUSIC.

Section "D."—1, Edison Manufacturing Company; 2, Bullock Electric Company.

Section "E."—1, Westinghouse Electric & Manufacturing Company.

Section "F."—1, Buckeye and Jandus Electric companies; 2, West-

ern Electrician; 3, M. R. Hutchinson; 4, Mexico Clay Works; 5, Cutler-Hammer Manufacturing Company; 6, Warren Electric Manufacturing Company; 7, Hazard Manufacturing Company; 8, Standard Underground Cable Company.

Section "G."—1, American Electric Telephone Company; 2, Stromberg-Carlson Telephone Company; 3, Wilhelm Telephone Company; 4, National Automatic Telephone Company; 5, Clark Automatic Telephone Company.

Section "H."—1, Historical Exhibits; 2, 500-volt Service Switchboard.

Section "J."—1, General Electric Company.

Section "M."—1, F. C. Perkins and D. & W. Fuse Company; 2, C. B. Rowell; 3, Waite & Bartlett Manufacturing Company; 4, B. & E. Hanfeld; 5, R. V. Wagner & Co.; 6, Incandescent Electric Light Manipulator Company.

Section "N."—1, Gould Storage Battery Company; 2, Onondaga

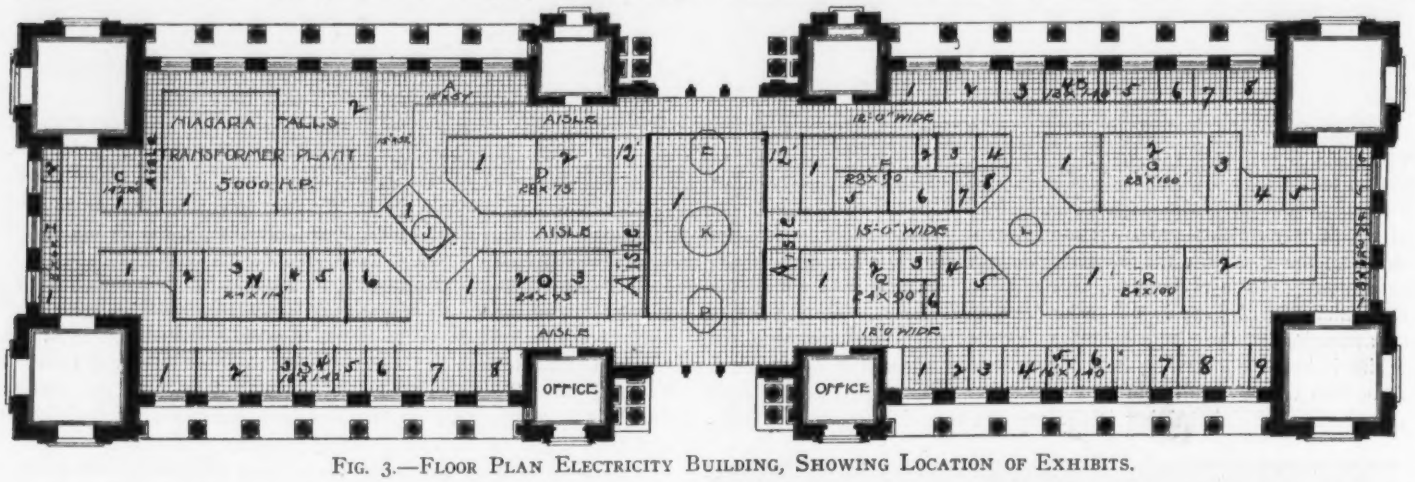


FIG. 3.—FLOOR PLAN ELECTRICITY BUILDING, SHOWING LOCATION OF EXHIBITS.

Dynamo Company; 3, Niagara Falls Power Station Models; 4, Stanley Instrument Company; 5, Northern Electric Manufacturing Company; 6, Stanley Electric Manufacturing Company.

Section "O."—1, Electric Storage Battery Company; 2, Holophane Glass Company; 3, Crocker-Wheeler Company.

Section "Q."—1, Brown Optical Company; 2, Buffalo Concessions Company; 3, Kate Fearn's Silk Loom; 4, Lea Manufacturing Company; 5, Safety Insulated Wire Company; 6, Eureka Tempered Copper Works.

Section "R."—1, Kellogg Switchboard & Supply Company; 2, Western Electric and Bell Telephone companies.

Section "S."—1, Arnold Electric Power Station Company; 2, Collective Exhibits; 3, Buchheit Badge Company; 4, Submerged Electric Motor Company; 5, Mann Brothers; 6, The Robbins & Myers Company; 7, S. S. McClure Company; 8, Buffalo Concessions Company.

Section "T."—1, P. B. Delany; 2, A. W. Hall; 3, S. Lubin; 4, Buffalo Candy Company; 5, Bettini Phonograph Company; 6, E. R. Johnson; 7, National Gramophone Company; 8, American Clock Company; 9, Mason Monogram Company.

The New Lighting Contract at Denver Voided.

A decision of more than usual interest is that just rendered at Denver, Colo., by Judge Palmer, in the suit brought by Perry L. Hubbard against the city of Denver and the LaCombe Electric Lighting Company to restrain the defendants from entering into a 10 years' contract to supply the city with 1000 arc lights for $90 a year a light. The plaintiffs contended that under the charter the city could not enter into a contract for which no appropriation had been passed to cover all the indebtedness implied in the contract. The effect of the decision is to make inoperative the contract between the city and the LaCombe Company until the suit is finally determined in the Court of Appeals. The decision does not involve the validity of the franchise granted the new company, but only the contract between the city and the company. The LaCombe Company is still empowered to operate its commercial plant and furnish light to private consumers.

Judge Palmer said: "The question involved in this case is whether the contract made between the city of Denver and Charles F. La Combe and his assigns for the lighting of the city of Denver with electric arc lights for a period of ten years is a good and binding contract. By this contract, the city of Denver agreed, among other things, to pay said LaCombe $7.50 a month a light for 1000 arc lamps of 2000-cp each, and $70 a year for each arc lamp in excess of 1000. The vital question is whether the city of Denver has the power under its charter to enter into the contract in question. It is a general and undisputed proposition of law that a municipal corporation possesses and can exercise the following powers and none other: First, those granted in express words; second, those necessarily or fairly implied in or incident to the powers expressly granted; third, those essential to the declared objects and purposes of the corporation—not simply convenient but indispensable. Any fair, reasonable doubt concerning the existence of power is resolved by the courts against the corporation and the power is denied. Of every municipal corporation the charter or statute by which it is created is its organic act. Neither the corporation nor its officers can do any act or make any contract or incur any liability not authorized thereby. All acts beyond the scope of the powers granted are void. Much less can any power be exercised or any act done which is forbidden by charter or statute.

"Among the powers granted by the charter to the city of Denver is the power by ordinance to 'Provide for the lighting of streets and public grounds and erecting lamp posts, electric towers and other apparatus.' The exercise of this power is limited in two ways:

"First, by authorizing the creation of a debt for specified purposes, such purposes not including public lighting. The charter having enumerated the purposes for which a municipal debt may be created, there is an implied prohibition that a debt may be created for other purposes.

"Second, by limitation upon the power of the city to contract as expressed in the following provision of the charter: 'The city council shall not order the payment of any money for any purpose whatever in excess of the amount appropriated for the current year, and at the time of said order remaining unexpended in the appropriation of the particular class or department to which such expenditures belong. Neither the city council nor any officer of the city shall have authority to make any contract or do anything binding on the city or imposing on the city any liability to pay money until a definite amount of money shall have been appropriated for the liquidation of all pecuniary liability of the city under such contract; or in consequence thereof; said contract to be *ab initio* null and void as to the city for any other or further liability; provided, first, that nothing herein contained shall prevent the city council from paying any expense the necessity of which is caused by any casualty, accident or unforeseen contingency happening—after the passage of the annual appropriation ordinance; and, second, that the provision of this section shall not apply to or limit the authority conferred by sections 7, 8 and 9 of this article, nor to moneys to be collected by special assessments for local improvements.'

"It appears by virtue of the terms of said contract the city of Denver became bound unto and liable to pay to Mr. LaCombe or his assigns the sum of at least $90,000 for the year immediately following the completion of the LaCombe arc lighting plant, and a like sum for the succeeding nine years, or an aggregate of $900,000, which sum would certainly be increased by the cost of more arc lights, which the growth of the city would command, and which under the contract would cost $70 each.

"The last provision of the city charter is mandatory, and persons dealing with a municipal corporation must at their peril take notice not only of the powers vested in a corporation, but of the mode by

which its powers are to be exercised, so far as such mode is mandatory."

Judge Palmer then cites the case of the Smith Canal Company against the city, and quotes the ruling of the court at that time that this clause of the city charter makes the appropriation of a definite sum of money an indispensable prerequisite to a valid obligation to pay money.

"It is admitted in the agreed statement of facts that the city has not at any time appropriated a definite sum of money or any amount of money whatever for the liquidation of pecuniary liability of the city under the contract provided for the ordinance or to meet the liability imposed upon the city by said contract, unless the annual appropriation ordinance operates as such appropriation. This ordinance appropriates $90,000 for public lighting of the streets of the city of Denver by arc electric lights of 2000 standard candle-power, and also for the payment of gas and electric light bills in the different city buildings outside of the fire and police department. It is manifest that the chartered requirement that a definite amount of money shall first be appropriated for the liquidation of all pecuniary liability of the city under a contract or in consequence thereof has not been complied with. The provisions of the appropriation ordinance fall short of meeting this requirement.

"The item of $90,000 appropriated for the year 1901 is for two purposes, first, for street arc lights, and, second, for gas and electric lighting in the downtown buildings. How much of this is appropriated for street arc lights or how much for downtown buildings, or how much to pay for incandescent lights or how much to pay for gas, is not disclosed.

"It therefore appears that a definite amount of money has not been appropriated for the expense of street arc lighting, as contemplated by the LaCombe contract."

Judge Palmer also states that in view of the fact that the Denver Gas & Electric Company offered to furnish lights for $60 apiece a year it was an abuse of the trust committed to the city council to reject that offer and donate the sum of $30,000 a year for 10 years to the LaCombe Company. With regard to the contention of the plaintiffs that the letting of the contract for public lighting is by the charter conferred to the board of public works, Judge Palmer states that while he is not prepared to state that the position is not well taken he does not consider it necessary to pass upon the question, as the clause of the charter which he quoted is sufficient to cover the case in point. He therefore declares the contract between the city and the LaCombe Company null and void.

The defendants gave notice that they would appeal.

Some Features of the Recent Wall Street Corner.

A panic or scare was caused in Wall Street last week by the discovery of a corner in Northern Pacific common stock, for which two powerful interests were bidding so fiercely to secure control that at one moment the price was driven up to $1,000—the stock barely earning 4 per cent. The result was, of course, tremendous excitement, and a great strain on telegraph, telephone, cable and messenger service. An estimate placed the number of messengers employed in the financial district during the day at between 2500 and 3000, and yet this huge force was entirely inadequate to meet the unprecedented demands made upon it. Every one of the big telegraph and cable companies had been under a strain for some time to keep up with the enormous business, but the demand on Blue Thursday eclipsed all records, and the messenger system threatened several times during the day to go to pieces.

The American District Telegraph Company usually employs about 150 boys in its Exchange Court office. During the last two weeks it had to increase this number to more than 300. On Thursday drafts were made upon all the up-town offices and branches until a force of 450 boys had been gleaned for the down-town service. This force, in turn, was overwhelmed with business in short order, and agents were sent out into the streets to hire extra boys. Clerks from the main office, and even linemen and the drivers of repair wagons, were pressed into the service, until during the afternoon a force of 500 messengers, nondescript and otherwise, was being rushed through the financial district by this company alone. Boys were given as many as 25 messages each to deliver. The American District Company collects messages for the Western Union Company. On Thursday the superintendent of the latter company asked for help in delivering its messages. It was said by the American District Company superintendent that this was the first time in 15 years that this has been done. At the Broad Street office of the Western Union it was said that never before had so many messages been received in the office in a single day. It was computed that the number would easily reach 10,000 up to the hour for closing the Stock Exchange.

The Postal Telegraph & Commercial Cable Company's down-town office early in the day received an extra force of 100 messengers from the main office, and was even then compelled to refuse many orders for boys.

The Bankers and Brokers' Messenger Exchange on New Street, which makes a specialty of furnishing messengers for the Stock Exchange, had 500 boys at work Thursday. This, according to Manager Jones, represents an extra force of 400 boys, and the manager was out searching the highways and byways for more boys.

At the offices of the Anglo-American, French, and other foreign cable companies it was stated that business for the day had been unprecedented. Extra messengers had to be employed.

Another interesting feature was that no fewer than 12 brokerage houses engaged electric automobiles from the New York Electric Vehicle Transportation Company to carry messenger boys with orders to and from the Stock Exchange. So crowded have been the wires of late, and the new Exchange is so far from most of the larger offices, that some means had to be devised to get messages to the floor more quickly than a boy could run with them. An automobile can be hired for $10 per day, and many of the houses state that during these busy times one is worth over $100.

Since the removal of the Stock Exchange to its temporary quarters in the Produce Exchange the growth of business has been so great that an extension of the telegraph and telephone facilities has already been required, and the new exchange was closed on Saturday last, largely with the object of permitting these extensions to be made.

Electric Lighting and Insurance.

The annual meeting of the National Board of Fire Underwriters was held last week in the rooms of the Board at No. 32 Nassau Street, New York City.

F. C. Moore, of New York, chairman of the Committee on Light, Heating and Patents, brought the attention of the board to the question of the life of electrical devices. He said that a president of a Western insurance company estimates that 25 per cent of the losses of the past year are due to these devices. He said that he had submitted a number of questions relating to electrical devices, and their dangers, to prominent electrical engineers throughout the country, but as yet has not received answers from all the engineers.

Mr. Moore said that an inspection of the devices at the Pan-American Exposition disclosed the fact that there was considerable defective wiring, and that a number of "mud" tubes had been used instead of porcelain tubes. Mr. Moore said that orders had been given for the necessary repairs.

Cheap Telephone Service in Indiana.

About a year ago a co-operative telephone company was organized at Bowers Station in Montgomery County, Ind., and those interested in it are loud in its praise. The plan of the company is for all who have a permanent use of the telephone to help bear the expense of putting in the switchboard, and the farmers buy the instruments and pay for the wire that gives them switchboard connection. Where two or more people use the same wire the expense is divided between them. In addition to this each subscriber pays $3 for the privilege of joining the company. A monthly fee of 25 cents is also charged. All members of the company have the free use of any connections with the exchange, while non-subscribers pay toll. Those in the company say they are getting good service at little expense. The company is not organized for profit, the 25 cents a month being used to keep up repairs and the expenses of the exchange. Nearly 40 towns are now represented in the company, and over 6000 telephones are connected. The last town to be connected is Kirklin, which is given free connection to the members of the co-operative company. It is the purpose of the company to keep on spreading, and it will in a short time have connection with Indianapolis, and the system operated by the long-distance company.

Electric Automobiles in New York City.

President Henry Sanderson, of the New York Electric Vehicle Transportation Company, in a circular to the stockholders announcing an assessment of $10 per share, says: "Your company has now reached a point where your directors deem it wise, in the protection and furtherance of its interests, to immediately make provisions for the better establishment of its present business and the proper meeting of future requirements. Earnings have steadily increased, the April income being the greatest in the company's history. The demand for vehicle service has been constantly in excess of the vehicle equipment.

"The new main station at Forty-ninth Street and Eighth Avenue, and the various sub-stations, conveniently located at necessary points throughout the city, have shown most satisfactory results. Additional stations must be provided, before next winter, delivery wagon facilities in particular being required. The Buffalo branch of the company is proving a desirable investment and considerable extensions are there in progress, more especially to meet the very profitable demand that is anticipated during the Pan-American Exposition.

"The Fifth Avenue Company, under your ownership, has largely extended its franchises and the value of this property. Improvement in tires and the mechanical construction of the vehicles and the great betterment in station facilities have largely modified the difficulties that heretofore have been a bar to progress and materially lessened the costs of operation. A new type of battery of more than double the mileage on one charge of electricity has been comprehensively experimented with, and, after operations covering 25,000 miles, has developed but few defects. This battery has, almost without exception, given reliable service and in successful operation will enable the company to enter into vigorous prosecution of its business along all lines of development."

Loss on English Postal Telegraphs.

Mr. Henniker Heaton, Conservative, in the House of Commons on May 10 drew attention to the annual loss of £700,000 in the English telegraph service, aggregating £8,300,000 since the Government took over the lines, and asked how the Government proposed to remedy this.

Sir Michael Hicks-Beach, the Chancellor of the Exchequer, admitted the correctness of the figures. The reason of the loss was that the public was more eager for rapid communication than the revenue warranted. Unproductive extensions must be discouraged.

Mr. Henniker Heaton asked also if the Government was prepared to lease the telegraph lines to a private company. The Chancellor of the Exchequer did not reply.

Electricity and the Copper Market.

Consul-General Mason at Berlin has written to the State Department a comprehensive letter on the production and consumption of copper in Germany, in which he says: "The recent decline in the price of copper to $335.78 per ton in the controlling market of England, together with the fact that the total European imports of that metal averaged only 18,091 tons per month during January, February and March, 1901, against 23,600 tons per month from April 1 to Dec. 31, 1900, have been widely discussed as indications of the restricted activity which now prevails in electrical and certain other branches of manufacture throughout Great Britain, France and Germany. That this lull is but temporary and due largely to the paralysis of export trade incident to the wars in South Africa and Asia is generally believed. Meanwhile, the slight decline in the price of copper brings that metal into closer harmony with the current values of steel and iron, and has already acted as a stimulant to consumers, who are counting on the steadily increasing production of North America to maintain the future price of copper at or even below its present value.

Although complete statistics for the year 1900 are not yet at hand, it is closely estimated that out of a world's produce of about 470,866 tons, North America yielded 268,787 tons, England 520 tons, Austria-Hungary 1130 tons, Russia 6000 tons, Chili 25,700 tons, Germany 31,950 tons, and Japan 27,500 tons—the remainder being mainly from Australia, Tasmania and Spain. The actual German consumption of last year was about 106,696 tons, as compared with 19,622 tons in 1880 and about 48,000 tons in 1890.

It is thought probable that the consumption of copper in Germany will not seriously decrease during the present year. How much will be used for electrical purposes is a point upon which opinions differ. A trade circular issued by Messrs. Aron, Hirsch & Sons, a leading copper firm at Halberstadt, shows that during the six years from Jan. 1, 1895, to the end of 1900, the increased consumption of copper in Germany, Great Britain, France and North America averaged 49 per cent, while the increase in the world's production during the same period was only 43 per cent, and it is said by the same authority that the total reserve stock of raw copper, instead of increasing, has diminished by 63,021 tons during the past six years.

The Signal Corps Telegraph in the Philippines.

A special dispatch from Washington to the New York *Evening Post*, says: A problem will confront General Greely, Chief Signal Officer, when he invades the Philippine archipelago in July. His force of officers will be cut in twain at that time, and his struggle will be, after inspecting the situation with his own eyes, to map out the remaining work of the Signal Corps so that 15 officers can perform the duties hitherto distributed among 30. The red lines on the official map of the Philippine Islands show a system of land wires and submarine cables stretching between extremes about a thousand miles apart, but so ramified as to compose a total length of between 4200 and 4300 miles, or enough to make a line from San Francisco to New York and back to Chicago. Over this system there pass an average of 10,000 Government messages a day, these messages averaging at least 100 words, so that, in round numbers, it may be said that 1,000,000 words are transmitted daily by telegraph on Government business. This is almost a necessity of the situation, in view of the absence of any proper postal facilities. It is the only efficient means of communication between the military and other functionaries of the Government. The abundant use of the wire, indeed, has given rise to a witticism by one of the signal officers, speaking of his army brethren at a certain headquarters: "They never send any dispatches; they merely file letters." It is natural that they do, if we reflect that the news of the first operations of our forces in Mindanao did not reach Manila for three weeks, whereas the same points on the same island can communicate with the capital now in 15 minutes.

CURRENT NEWS AND NOTES.

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS meets at Milwaukee, Wis., on May 28, with headquarters at the Plankinton House. Among the papers are "Requirements of Electricity in Manufacturing Works," by Professor W. S. Aldrich; "Blue Printing by Electric Light," by H. G. Reist. There will be visits to the Allis, Vilter, Christensen and other Milwaukee shops of interest to the profession.

ELECTRIC FIRE ENGINE.—A Pittsburg correspondent writes us that J. E. Weaver, a machinist of Allegheny City, Pa., has built an electric fire engine. The machine is completed and the Allegheny City fire department will give the new invention a trial at the earliest opportunity. The apparatus differs from the steam fire engine in so far as there is no boiler and engine. Instead, there is an electric motor of 40-hp capacity which will do the work. The inventor obtains his current from the trolley wires. The new engine weighs between 5000 and 6000 lbs.

MR. MORGAN AND THE CABLE STORY.—The report from Paris that Mr. J. P. Morgan had leased one of the Atlantic cables for the day during Friday last week is declared by the managers of the various cable companies to be without foundation in fact. It was pointed out that the agreement entered into at an international convention at Berne several years ago would prevent such an arrangement. Another fact which would stand in the way was that, in order to reach a cable, it would be necessary to have a land line from Paris to the cable terminal. Since all the French lines are controlled by the Government it would, under no circumstances, lease one of its lines to a private individual. The story, therefore, seems to have been completely pulled to pieces in the light of facts.

LIBRARY FOR SCHENECTADY.—It is reported that the General Electric Company has donated $15,000 to the city of Schenectady with which to purchase a site for the proposed $50,000 library to be erected in that city by Mr. Andrew Carnegie.

LONG-DISTANCE HYPNOTIZING.—A test of hypnotizing over telegraph and telephone wires between Denver, Colo., and Pueblo, 120 miles, is reported by the Colorado papers. Apparently the ability to do such a thing has been proved once more, but the utility of it as a new industry was not clearly established.

A LARGE UNDERGROUND ORDER.—The village board of Riverside, a small suburb of Chicago, recently ordered the Chicago Telephone Company to put its seven circuits running to its seven subscribers in the town underground. Naturally, the company couldn't see where the profits or utility came in, and preferred to take out the telephones rather than go to the expense of underground construction.

DISAPPEARANCE OF CABLES IN NEW YORK.—The cable on the Columbus Avenue line of the Metropolitan Street Railway Company was taken out on Saturday night last, and the electric conduit system inaugurated. People along the line gave the last cable car a lively farewell, fireworks being set off at some points, and there was much cheering. The Broadway line is now the only one in the city operated by cable, and this is practically ready to give way to electric power.

ELECTRICAL EXHIBITION, CHICAGO Y. M. C. A.—The Y. M. C. A. Electric Club, of Chicago, gave an exhibition of recent electrical developments for the benefit of the general public at its rooms in the Association Building the evening of May 7. The Y. M. C. A. electrical laboratory class also made a display. This class is doing good work in electrical education evenings for its members, and has become one of the recognized means of night school electrical training in that city.

VIBRATION IN UNDERGROUND.—The committee which has been inquiring into the vibration on the London Tube (underground) railway has made a report which says that the vibration is undoubtedly caused by a large proportion of the weight of the electric locomotives not being borne on the springs. They also say that the rails employed by the company are lacking in rigidity. The company has ordered a new type of locomotive, and will try to employ stiffer rails. The committee expresses the belief that the problem of preventing vibration can be solved.

CABLE EXTENSION IN AFRICA.—United States Consul-General Guenther, at Frankfort, in a report to the Department of State, says: "The Central African telegraph line, connecting Brazzaville with Loango, on the west coast, has been completed, and direct communication with Libreville may be had from any station of the English Atlantic cable." He adds that the cable from Brazzaville to Stanley Pool, which is being laid to connect with the telegraph system of the Congo State, will ultimately be extended to Lake Tanganyika, where it will form a conjunction with the German East African system. Mr. Guenther writes also that work has been begun on a new cable between England and Germany, which will be the seventeenth in existence between the two countries. The line runs from Emden to Barton.

FIRE PROTECTION CONFERENCE.—The fifth annual meeting of the National Fire Protection Association will be held in Chicago on June 11, 12 and 13. The opening sessions will be held in the assembly room of the Chicago Underwriters' Association at the Grand Pacific Hotel. The last day's conference will be held in the demonstration room of the Underwriters' Laboratories, No. 67 East Twenty-first Street. Among the interesting papers to be presented are: Report of Committee on Electric Fire Pumps, C. M. Goddard, chairman; Report of Committee on Thermo-Electric Fire Alarms, F. E. Cabot, chairman; Report of Committee on Uniformity of Requirements, H. A. Fiske, chairman; Report of Committee on Devices and Materials; W. C. Robinson, chairman. Laboratory demonstrations comprise an exhibition of methods employed in testing hand chemical fire extinguishers under the standards adopted, with explanation of results obtained in a number of tests; exhibition of methods employed in testing cotton rubber-lined hose under the standard adopted; exhibitions of the methods employed in testing automatic sprinkler heads: (1) pressure tests for determining leaking point; (2) oven tests and bath tests for determining fusing points; (3) distribution and capacity tests; (4) methods employed in effecting corrosion and results of tests of corroded and coated heads; (5) miscellaneous tests.

ELECTRIC FURNACE PROCESS.—Some years ago Leon Paul Hulin, of Modane, France, proposed a method of electrolytic decomposition, called by him "electroly-filtration," wherein the ions were liberated upon unsubmerged porous electrodes, and the products transferred through them by the hydrostatic head of the electrolyte. A patent for what seems to be the electric furnace analogue of the Hulin process has just been issued to Alfred H. Cowles, of Cleveland, Ohio, who was prominently identified with the early practice of electro-metallurgy in this country, and especially with aluminum bronze manufacture. A crucible of porous carbon, surrounded by a water jacket spaced away on all sides in such manner as to form an intermediate condenser, forms one electrode, while the other takes the shape of a carbon rod, inserted through a cover which hermetically seals the mouth of the crucible. Upon electrolysis in this crucible of a fused electrolyte yielding a gaseous ion, or upon reduction therein by carbon of a compound yielding volatile products, these pass through the porous carbon walls under pressure of the reaction gases, are condensed on the inner walls of the water-jacket and tapped off. The process is described with reference to the reduction by carbon of sodium aluminate, the products being sodium, which passes through the walls, and aluminum carbide, which remains in the crucible; or if copper or its compounds be present, aluminum bronze is formed. The operation necessitates the use of extremely high temperatures to avoid clogging the pores of the carbon by condensed sodium, and for this reason must compare unfavorably as regards current efficiency with those processes in which the alkali metal is obtained directly in the liquid condition.

MOTOR REGULATION.—Two belated patents on motor regulation were issued April 13, one to Dr. S. S. Wheeler on an application filed Sept. 24, 1894, and the other to James Burke on an application filed March 22, 1895. Both of the patents relate to the control of motors operating on constant-potential circuits. Two methods are described for carrying out the principle involved in the Wheeler patent, in one of which a dynamotor is used and a motor-generator in the other. In either case one of the regulating armatures is in series with the armature of the motor to be regulated, and the brushes of the other regulating armature are connected to the brushes of the working motor. In the case of the dynamotor this later circuit contains a regulating rheostat, while in the case of a motor generator the two regulating fields are controlled by rheostats. In the case of the dynamotor the speed of the regulating armature is controlled by varying the load on the generator side, which is done by means of a rheostat in the circuit connecting this side with the working motor brushes. When the speed of the regulating armature is low the counter e. m. f. of its motor side is correspondingly low, and therefore the working motor has impressed upon it almost the entire e. m. f. of the working circuit. If by means of the rheostat the load on the generator side of the dynamotor is reduced, the speed of the armature is correspondingly increased, thereby throwing a larger counter e. m. f. into the circuit of the working motor, and thus reducing its impressed e. m. f. It will be noted that the current generated in the dynamotor is fed to the armature of the working motor, thereby assisting it in its work. When a motor-generator is used there is no rheostat in the circuit between the regulating generator and the working motor, the regulation being effected by means of a field rheostat common to both the regulating motor and generator fields, which latter are in parallel. The Burke patent describes an arrangement in which there are two regulating machines connected in series to the working circuit, the working motor being connected across the terminals of one of these machines, both of the fields of which can be regulated. By proper regulation of the fields the working motor may be supplied with an e. m. f. much below that of the working circuit, or with an e. m. f. much above that of the working circuit, or with e. m. f.'s anywhere between these limits. The regulation consists in varying the relative strength of the two fields and in reversing the direction of one of the fields.

A POWER EXCHANGE is being established at Rochester, N. Y., with the object of inducing manufacturers to settle there and use the electric power now being developed on a large scale from the Genesee Falls. It is practically a board of trade, and is already negotiating for various industries that can move there and use the power to advantage.

THE LATE J. C. HENRY.—Note was made in these pages last week of the death at Denver of the well-known electric railway inventor, J. C. Henry. Denver papers to hand give accounts of the funeral and show him to have been held in high esteem locally. It is understood that not long before his death Mr. Henry made an exclusive contract with the Stanley Electric Manufacturing Company for the use of his patents so far as they related to vehicles moving on a fixed track, and including his "regenerative controller" devices.

LONG-TRANSMISSION LINE.—An official test of the Stanard Electric Company's lines, switching stations and step-down transformers in San Jose, Calif., was made on May 4, in the presence of Prince Poniatowski and other officials. Current was transmitted at 42,000 volts, the distance of transmission being 100 miles. Again California has opened the longest commercial electric power transmission line in the world. The current is supplied from the generating plant of the Bay Counties Power Company, on the North Yuba River. The Standard Company will not be able to start up its own generating plant for some months.

LETTERS TO THE EDITORS.

Electro-Chemistry.

To the Editors of Electrical World and Engineer:

Sirs.—In the suggestive editorial, "Electro-Chemistry," in your issue of April 27, you do not seem to fully realize the good work that is done in this country by the younger teachers of physical chemistry. For example, I had the benefit of a very efficient course in electro-chemistry under Dr. Robb, using Leblanc's "Electro-Chemistry," at Trinity College, Hartford, and another course in electro-analysis, under Dr. Riggs, before I studied in Germany. Then both Professor Richards, of Harvard, and Professor Whitney, of the Massachusetts Institute of Technology, are at the heads of special laboratories, where a number of investigations in this subject are carried on, not to mention a number of other followers of Nernst and Ostwald in America.

But your point that in the majority of American institutions electro-chemistry is inadequately taught and has inadequate laboratory facilities, as compared to the German teaching of the subject, is quite true, in my opinion. There is a great need for young electro-chemical engineers who understand the theory of electro-chemistry, and have the practical knowledge of American methods and American conditions of high-priced labor, and the consequent necessity for simple processes and automatic apparatus.

With the abundance of American capital looking for investment at the present time and our cheap water-power, splendid opportunities are offered for the development of electro-chemistry and especially electro-metallurgy, far beyond the present state, just as has been done in electrical engineering with brilliant success in the past 10 years. It must be remembered that there is much less self-induction in the "brain circuits" of American capitalists than in foreign capitalists, and that American engineers have usually a clear distinction between beautiful "laboratory" processes and those that allow a fair margin of profit after 15 per cent has been charged to interest and depreciation. All things considered, the outlook for progress in these two lines is attractive even if the expectations of the past few years have not been realized as yet.

With regard to the present "dissociation theory" of electro-chemistry, it certainly bears the stamp, "Made in Germany," and the commercial success of the applications and the recent innovations in Germany are the best tests of its soundness. A theory should be to the engineer what the lathe is to the machinist, a tool to accomplish work. As long as one theory enables one to prophecy and explain phenomena better than any other, it should be kept in commission. But when another theory comes up that does the work better, then the old theory should be thrown in the scrap-heap and allowed to rust. The charge that the "dissociation theory" of electrolysis is transcendental, is common to many theories. It can be said that it is hardly so metaphysical or so autocratic in character as the old Dalton atomic theory which assumed the existence of 60 or 70 infinitesimal indivisible particles, each with its own specific properties; yet the tremendous advances that chemistry has made are due to this theory. So the questions whether atoms, "electrons" and ions have a real existence, as we imagine them, what is the difference between positive and negative charges, how can zinc have an electrolytic solution tension of some 10,000,000,000,000,000,000 atmospheres, while mercury has one of 0.000,000,000,000,000,1 atmosphere are as subtle as any questions that perplexed old "schoolmen" of the Middle Ages. What we know is that certain things act very much as if they had the properties we ascribe to them in our imagination. The theory that helps us to learn more and to do more is the *desideratum*. A theory is merely a means to an end, and as such should be judged (1) by its efficiency, (2) by the ratio of its probability to improbability.

On these standards, the modern German theory of dissociated ions and its sister, the Nernst theory of e. m. f. stand easily first. They give us the *concrete conceptions* that explain unknown causes in terms of known phenomena. The other theories that attempt to explain the mechanical action can be termed "also rans," to use a bit of expressive colloquialism.

CAMBRIDGE, MASS. WOOLSEY MCA. JOHNSON.

To the Editors of Electrical World and Engineer:

Sirs.—In an editorial of the ELECTRICAL WORLD AND ENGINEER of April 27, the desirability is pointed out of establishing in our technical schools chairs of electro-chemistry and of offering instruction based upon the teachings of the Arrhenius-Van't-Hoff-Thomsen-Nernst-Ostwald school, and it is further suggested that only those having the training of this school should be selected to fill such chairs.

The desirability of instituting courses in electro-chemical engineering in our schools arises from the rapidly increasing importance which the electro-chemical industries are assuming among the industries of this country. If such industries are the result of the application of the theories advanced by the Arrhenius-Van't-Hoff-Thomsen-Nernst-Ostwald school, then the training should undoubtedly be given along those lines; but such is not the case.

Can a single electro-chemical industry be traced to the application of such teachings? Is our aluminum industry helped by the modern theory of dissociation? Is the calcium carbide industry an outgrowth of the study of osmotic pressure and electrolytic solution tensions? How far has the process of electrolytic copper refining been modified by them? Why is it that technical electro-chemistry has made more rapid progress here than abroad, in spite of the fact that there is a scarcity of electro-chemists in our country trained in the German schools? There is no reason other than that electro-chemical phenomena which have long been known have been taken up by our progressive engineers and, through their efforts the former laboratory experiments have been enlarged into industrial processes.

There is no question but that the electrolytic theories recently set forth, which have seemed to explain and classify some of the phenomena, have served as a stimulus for further investigation, but it is equally certain that a too firm adherence to such theories will be detrimental to further progress. The dissociation theories and dissociation constants apply only to dilute aqueous solutions and not to concentrated solutions with which most industrial processes have to deal. Such theories are held in reverence by certain physical chemists, while the technical men know that in all fused and non-aqueous electrolytes with which they must work, the theories do not apply. It is a noteworthy fact that recently published works in technical applications of electro-chemistry devote a few pages of the work to an explanation of modern theories and then break loose from them completely and explain the technical side of the various processes without further reference to them.

There is no question but that an explanation of what the electrolysis of an electrolyte really is will offer a great impetus to electro-chemistry, industrially applied, but in the lack of such explanation and until such is forthcoming would it not be more desirable to train our electro-chemical students so that they may be of most value under the present conditions? The technical graduate who is best equipped for entering into this promising field of applied electro-chemistry must have an engineering training, and a very broad

one at that, which will enable him to repeat on an industrial scale experiments which were performed even as far back as the time of the Faraday-Berthelot school. The owners of electrical industries are not advertising for men to determine the dissociation constants at extreme dilution, or to measure solution tensions and osmotic pressures under ideal conditions, or to determine the velocity of migration of ions, but rather men who can operate machinery, design and work electrolytic and chemical appliances so that a kilowatt-hour may be made to do the greatest service. A familiarity with the teachings of the Arrhenius-Van't-Hoff-Thomsen-Nernst-Ostwald school is desirable to technical men only in showing to what a limited extent they can be applied in practical working, and there is no reason that the same intelligence, knowledge and inventive faculty which has given such impetus to our electro-chemical and electro-metallurgical enterprises in this country may not be able to produce men who can give instruction to those who are to contribute to its further progress.

C. F. BURGESS.

MADISON, WIS.

DIGEST OF CURRENT ELECTRICAL LITERATURE.

DYNAMOS, MOTORS AND TRANSFORMERS.

REFERENCES.

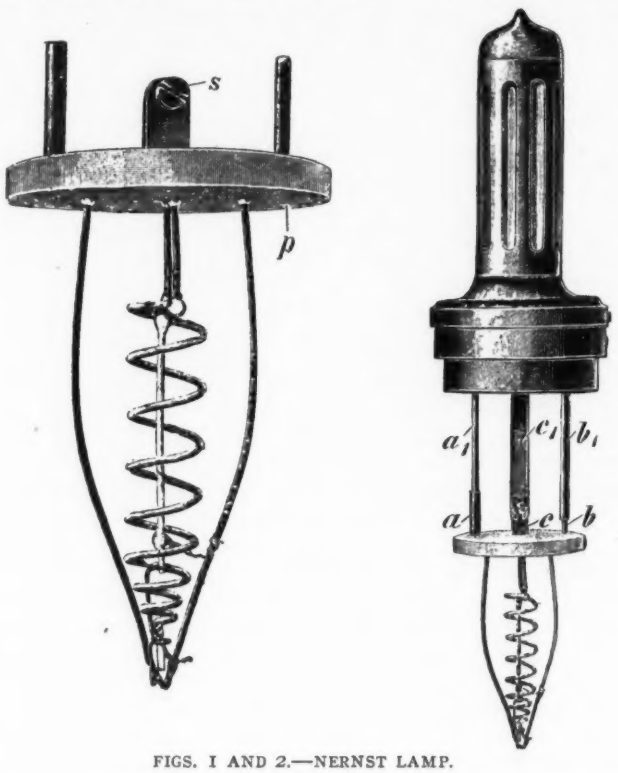
Effect of Self-Induction in the Rotor of an Induction Motor.—An illustrated didactic article setting forth the reaction taking place within the rotor of an induction motor due to self-induction, and giving formulæ for calculating the torque, at full speed and at standstill.—*Am. Elec.*, May.

Polyphase Sub-Station Machinery.—EBORALL.—An abstract of his paper read before the Brit. Inst. of Elec. Eng., noticed before in the Digest.—*St. R'y Jour.*, May 4, and Int. Ed., May.

Direct-Current Dynamos in Parallel.—ADAMS.—An elementary article with diagrams discussing the operation in parallel of series dynamos and of compound dynamos.—*Am. Elec.*, May.

LIGHTS AND LIGHTING.

Nernst Lamp.—Some notes, taken from a circular of the General Electric Company, of Berlin, which is about to place 100 and 200-watt Nernst lamps on the English market. One hundred-watt lamps are at present made for 110 and 220-volt, but the 200-watt lamps



FIGS. 1 AND 2.—NERNST LAMP.

only for 220-volt circuits. The lamp to be introduced is called model A, and is intended to replace groups of ordinary incandescent lamps. One 100-watt 65-cp Nernst lamp replaces four ordinary 50-watt 16-cp incandescent lamps; one 200-watt lamp replaces 8.5 ordinary 16-cp incandescent lamps. The lamp consists essentially of a filament, support, pendant, globe and series resistance (the latter on account of the negative temperature coefficient), and for starting the current of a parallel resistance for heating the filament, and a cut-out for breaking the circuit of this resistance when the filament is sufficiently heated to act as a conductor. Fig. 1 shows the burner, model A, in three-quarter full size, Fig. 2, the lamp with globe and hanger removed in one-quarter full size. The filament can be easily replaced without damage if only the porcelain disk, to which it is fixed, is taken hold of. The screw *s*, in Fig. 1, must first be loosened, when the whole burner can be withdrawn and a new one put in, a mistake being impossible, as the wire a_1, in Fig. 2, fits only into the tube *a*, and the wire b_1 into *b*; the operation is finished by the contacts c_1 and *c* being brought together and the screw *s* tightened. The makers calculate that the replacement of four 50-watt 16-cp ordinary incandescent lamps by one 100-watt Nernst lamp yields a saving of cost of operation of 45.75 per cent, and the replacement of 8.5 ordinary 16-cp incandescent lamps by one 200-watt Nernst

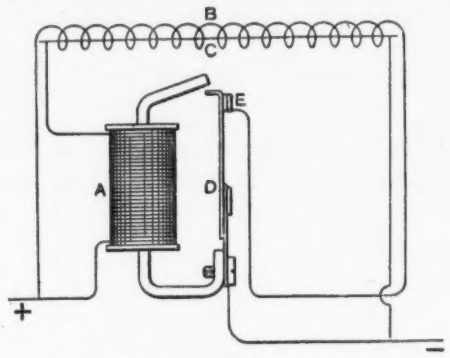


FIG. 3.—NERNST LAMP.

lamp a saving of 51.7 per cent. The first cost of the Nernst lamp is $3.12 for the 100-watt size and $3.62 for the 200-watt size. The company is also working on 40 and 80-watt lamps, "model B," with candle-powers of 25 and 50, respectively. Fig. 3 shows the connections. When the current is switched on, the heating resistance *B*, which is made of fine platinum wire, about 46 to 50 b. w. g., wrapped on porcelain and then dipped in liquid porcelain, is in parallel with the filament *C*. When the latter becomes heated current passes through it and the electromagnet in series, the steel spring is attracted, and the circuit of the heating resistance is broken at *E*. When the current is switched off the spring flies back, remaking contact at *E*.—Lond. *Elec.*, April 26

POWER

REFERENCES.

Waterwheel Regulation.—GARRATT.—An illustrated article on the practical side of the problem of speed regulation of water-power plants, with references to actual installations. He deals with the general design of the plant, of waterwheel gates, of waterwheel-gate connections and of waterwheel governors.—*Cassier's Mag.*, May.

Electrically Controlled Bulkhead Doors.—WALSH.—An article in which the author points out the superiority of electrically controlled bulkhead doors over hydraulic and pneumatic methods of control.—*Am. Elec.*, May.

Niagara.—BUCK.—An illustrated article on the development of the Niagara Falls transmission plant in recent years, with a summary of the different companies which are supplied with electric energy, and of the different purposes to which the energy is applied.—*Cassier's Mag.*, May.

Economy in Steam Production.—Obert.—An article showing wherein the operating expenses of a steam plant might be considerably lessened, and pointing out the necessity of a clean and well-lighted boiler room.—*Am. Elec.*, May.

Traction.

The Sprague Multiple Unit System.—Sprague.—An illustrated authoritative article. Over 60,000 horse-power of equipments are in use. In general, each motor car is equpiped with controllers which can be operated independently, or so arranged that when the cars are connected in one train, all of the controllers can be operated from one point by means of a pilot motor. The circuits of the pilot motor and those of the car motors are independent of the train lines. Each car equipment is controlled by the joint operation of a speed controller and reverser. The system is illustrated by several diagrams. On a car there are four distinct circuits, namely, (1) the car-motor circuit, which includes the main motors, the reverser, rheostat and motor grouping circuits, (2) the local controller circuit, which includes the magnetic coils, pilot motors or whatever moves or controls the main motor controllers, (3) the platform switch line. This on a single car is a part of the local controlling circuit and on a train energizes all the local controlling circuits, (4) the train or governing line, which is a cable running from one end of the car to the other, which at one or more points is connected to the platform switching line (3) and to the local controller circuits (2). The various uses of these circuits are described, after which views and descriptions of the principal apparatus are given.—*St. R'y Jour.*, May 4, and Int. Ed., May.

Power Consumption of Motor Cars Using Two and Four Motors Per Car.—Two papers read before the New England St. R'y Club. The first paper is written by Mr. Pestell, electrical engineer of the Lynn & Boston Railroad. Tests were made with the same size motors, and the power consumption was between 20 and 25 per cent greater when four motors were used than with two motors. This was due partly to the increased losses in the motors and friction, and also because the motors, being heavily loaded, were working at greater efficiency. He then gave some figures showing the watt-hours per car mile, under different conditions. These varied from about 1400 to 3000. The fact that the two-motor equipment was heavily loaded was shown from the fact that the temperature after running seven hours was 94 degs. C. over that of the surrounding air, whereas the four-motor equipment reached only 66 degs. C. rise. This made the deterioration of the two motors more rapid. A second paper on the same subject was then read by Bigelow, of the Boston Elevated Railway Company. He found that the four-motor equipment took about 50 to 60 per cent more current, the weight being about 18 per cent greater than the two-motor car, but as the speed was greater the actual increase in power required was only from 12 to 27 per cent. When hauling trailers with a four-motor car he found that about 25 per cent of the weight on driving wheels on the rear rails was available for drawing trailers. If more was attemped, the wheels slipped. He did not think the depreciation when two motors were used per car was due to this fact, but was because the motors were overloaded. For this service he believed two motors per car best, though Pestell took the opposite view for his own conditions. In the discussion some figures were given on the speed of acceleration with different kinds of motors. Bradford stated that they used wattmeters on all their cars, and so checked the consumption of current by the motorman. Others followed the same practice and explained how the motormen were checked up, and testified that this had effected a saving in the total consumption of power.—*St. R'y Jour.*, April 20, and Int. Ed., May.

The Proper Way to Run Single-Motor Trucks.—Henry.—The writer refers to the use of double-truck cars with a single motor on each truck, and states that it is usually the practice to have these motors face in opposite directions; that is, if the front wheels are driven in one truck the rear wheels will be driven in the other truck, and vice versa. He believes that it is better to have the same set of wheels driven in each truck, because the tendency of the motor to rotate around the axle to which it is connected will vary the load on that axle. Thus, in the case cited, the driven axle of the front truck will have a greater tractive effort on the rails than the rear axle of the rear truck, consequently the rear wheels will slip when the motors are running in the series position, and there may not be over 50 volts on the front motor, while the rear may have 450 volts. When the controller passes from series to parallel, there is a sudden kick or jerk on the first motor, when it is instantaneously changed from 50 to 500 volts. The writer believes that where there are steep grades the motors should be put on the rear end of each truck, and where there is no danger of slipping, on the front end, as this would be easier on the track.—*St. R'y Jour.*, May 4, and Int. Ed., May.

Automatic Controller Handle.—This device compels the motorman to turn his controller handle slowly and so prevents him from putting an overload on his motors. There is a second handle close to the main handle, which moves the pawl to which it is connected. This pawl strikes against a projection on a ring around the controller spindle and has to be moved to allow the controller to advance to the next point. The controller handle can, however, be thrown backward from any point quickly, as the pawl is hinged so that when turned backward it will slide along the top of the ring. In another form of handle the auxiliary handle is omitted, and the pawl is actuated by moving the main controller handle back and forth.—*St. R'y Jour.*, May 4, and Int. Ed., May.

A New Rail Bond.—A description of a new bond which consists of a flexible ribbon soldered to the rail by a simple and inexpensive process. The ribbon is made of strips of annealed copper melted together at the feet, which are placed against the rails, and an arch is made in the center. It is always in sight, and therefore readily inspected, and the soldered contact remains good for an indefinite period.—*St. R'y Jour.*, May 4, and Int. Ed., May.

Pole Setting on the New Orleans Drainage Commission Lines.—An article with diagrams showing the method of setting poles along the railroad tracks, gutters and marshy districts of New Orleans. In very soft ground the poles are fastened to piles driven 26 ft. below the surface of the ground, while the greater number of the poles are set in wooden boxes embedded in concrete settings; clean, sharp sand being poured around the pole so that in removing the latter and replacing it by another the box and concrete setting are not disturbed.—*Am. Elec.*, May.

The Proper Wheel Section for Interurban Railways.—These roads usually operate over their own right of way with an exposed rail, and at a speed of from 40 to 50 miles per hour. The proper wheel section would be very easy to determine if the cars did not also have to enter the cities at the termini over the city tracks. Usually the groove in the city tracks and crossings is built for a wheel flange not over 9-16 inch deep, and ¾ inch thick. With the cast-iron wheels used almost exclusively in American work, it is very difficult to cast chilled wheel flanges of this size without chilling the flange all the way through, and at the high speeds used outside the city these flanges are hardly strong enough. The first point made by the writer is to be sure that the wheels are put into the truck exactly square. If this is not done, the wheels will wear unevenly. He also recommends care in braking, so that the wheels will not be unduly heated up during braking. The steam roads in this country use flanges 1⅛ inch deep, but 1 inch is deep enough on practically all electric roads, while the width should be of 1 inch to 1⅜ inches, provided the grooves in the rails in the city are large enough to accommodate this size.—*St. R'y Jour.*, May 4, and Int. Ed., May.

United Power & Transportation Company.—An investment company, which owns practically all the stock of a number of operating street railway companies. These latter are all within 200 km. of Philadelphia, but the company does not plan to keep its investments all in that section of the country. Altogether, the company owns 11 electric railway power stations and 4 electric light stations. Some of these contain direct-connected apparatus, but most of them are belted, partly because they were among the early stations to be built and partly because the prevailing low cost for fuel in the territory covered has not made the reconstruction of the stations according to modern economical methods an immediate necessity. Two of the lines use three-phase transmission with rotary converters.—*St. R'y Jour.*, May 4, and Int. Ed., May.

Gross Receipts of Companies in America.—A comparison of the gross receipts of 224 street railway properties arranged in five groups, according to their gross earnings. The average increase in earnings in the first group is 19.7 per cent., in the second group is 14.07 per cent, in the third group 21.83 per cent, in the fourth group 12.99 per cent, in the fifth group 13.12 per cent. The total average increase is 16.34 per cent.—*St. R'y Jour.*, May 4, and Int. Ed., May.

Germany.—Several German street railway companies have been obliged to introduce 2.5 cent fares by the municipalities. The results have not borne out the sanguine expectations of those who thought that they would be profitable. A report of the Dresden company shows that while the number of passengers was greater, a

larger number of cars had to be run, and the average passengers per car were only 3.9 as compared with 4.1 of the previous year. In Berlin, 9.56 per cent more passengers were carried, the receipts were 8.82 per cent greater, and 10.16 per cent more km. were run. The ratio of expenses to receipts was 59.65 against 56.24 the previous year. An abstract is then given of the report of the Hamburg Street Railway Company.—*St. R'y Jour.*, Int. Ed., May.

San Francisco.—Some notes on the Market Street R'y of San Francisco. This road was bought by the Southern Pacific Railroad Company in 1871, and since then has developed into a very extensive system, which includes horse, cable, electric and steam power. There are many very steep grades, the cable cars in some places operating on a grade of 22 per cent, and the electric lines on 17 per cent. In running down the hills with the brakes on it is sometimes thought advisable to turn on a little current in order to keep the wheels moving and so prevent sliding on the track. Both track and wheel brakes are used. The motors are thoroughly overhauled every six weeks, and the brushes are changd every night, one set being used on alternative days. In case of fire, the current is turned off from the feeders on that section, and is not turned on again until word comes from the place of danger.—*St. R'y Jour.*, May 4, and Int. Ed., May.

Storage Batteries at Cleveland.—An article on the use of a storage battery located 3 miles from the terminal of a railway, and 7 miles from the power station. It was found that the original cost of the battery would be only one-third that of the copper for keeping up the voltage under an ordinary load. The curve shows the variations in volts and amperes in the input and output of the battery. The voltage averages 540 while the battery is charging.—*St. R'y Jour.*, May 4, and Int. Ed., May.

Nottingham,—The Corporation of Nottingham secured control of the old horse railway single-track line in that city a few years ago, and is converting it into an electrically operated road. The lines have been extended from 16 km. of single track to a double-track line, which is equivalent to 64 km. of single track. Before deciding upon the system of traction, a great deal of thought was given to the subject of the best system, and two engineers were sent to America to investigate the systems in use there. The overhead trolley was the one adopted. The old tracks were laid upon very meagre foundation, which has been changed throughout by the introduction of a permanent one having a heavy concrete foundation, and made upon the most modern lines. The new rolling stock consists of heavy double deck cars. The overhead construction consists almost entirely of center-pole lines, every other pole carrying an arc lamp. The power station is yet incomplete, but the site has been chosen and considrable work is already done on the buildings and machinery. At present the power is obtained for the operation of the tramway from the electric lighting station.—*St. R'y Jour.*, May 4, and Int. Ed., May.

Boston Elevated Railway.—The structure of this road is now completed, the last girder having recently been put in place. A novel feature of the road is illustrated. Where the elevated system ends, a surface line forms a continuation. The surface lines are brought up on an incline to the same level as the elevated tracks so that passengers can change from one system to the other without ascending or descending stairways. A view of the insulator used for the third rail is given in the article.—*St. R'y Jour.*, May 4, and Int. Ed., May.

REFERENCES.

Distribution for Street Railways.—BANCROFT.—A comparison of various systems of electric distribution for street railways. He first discusses distribution from a direct-current station or from an alternating-current station with converter sub-stations. He also discusses the booster system and the three-wire system, and refers briefly to the use of alternating-current motors on cars and to the storage battery system.—*Cassier's Mag.*, May.

Paris.—A table showing receipts, operating expenses, car miles run, etc., for omnibuses, horse cars and motor cars on the lines of the General Omnibus Company, of Paris. Statistics are also given of the cost per car mile of the principal different motive powers used. —*St. R'y Jour.*, May 4, and Int. Ed., May.

Sprague Multiple-Unit System.—CHILTON.—A second article on the Sprague multiple-unit system, in which the author discusses specifically the car motor circuits and their controllers.—*Am. Elec.*, May.

Railway Car Notes.—WEEKS.—An article giving some practical suggestions on the lubrication and care of car truck boxes.—*Am. Elec.*, May.

How to Make Non-Paying Roads Pay.—COOPER.—A continuation of his long serial. He discusses the checking and accounting of employees as well as one or two other subjects. He believes that a record should be kept of the gross earnings of each line and car for each day, and gives rules for making such a record. He then takes up the subject of recording the efficiency of employees and states that a careful record should be kept of the merits and demerits of each employee.—*St. R'y Jour.*, May 4, and Int. Ed., May.

INSTALLATIONS, SYSTEMS AND APPLIANCES.

Switchboards.—BOYLES.—A paper read before the Cleveland Elec. Club. He first discusses the general arrangements of switchboards, and states that it is usual in stations of moderate size to place all the conductors from each generator to the switchboard in a separate duct of iron pipe suitably insulated, terra cotta or other fire-proof material, so that in case of breakdown to any one machine the connections of the other machines would not be affected. In high potential work each bus-bar should also be in its own fire-proof compartment. With alternating-current boards with an average of from 4000 to 6000 kilowatts and from 6000 to 16,000 volts, either air switches or oil switches should be used. With the former, the different parts are separated by suitable barriers and considerable space must be allowed around the switch. With the oil switchboard the contact is broken in oil. These switches can be operated either by compressed air or electricity. The compartments around the bus-bars should be of soapstone or brick, and covered with flame-proof doors. It is often advisable to divide the bus-bar compartment into sections connected together through switches. He then describes how the cable should be supported, and the apparatus on each panel. Where the generator is large, it is better to put the field rheostat near the generator and control it electrically or otherwise from the switchboard, as this will save a considerable amount of copper. The exciter switchboard should be separate from the main current switchboard. Recording wattmeters should be used on each generator, and on each outgoing feeder. The writer then describes the equipment of the new board of the Cleveland Electric R'y, which consists of panels for one 2400-kw generator, one 2000-kw generator, one 1600-kw generator, one 500-kw generator, to be used either as a generator or a booster; three 500-kw generators, one special booster feeder, and fourteen special feeders and seven ordinary feeders. He then describes the equipment of each.—*St. R'y Jour.*, April 27, and May.

REFERENCE.

A Combined Electric Lighting and Steam Heating Plant.—ZURFLUH.—An illustrated article describing a plant originally designed to light and heat two office buildings in Springfield, Ohio, but which was subsequently enlarged to take care of some commercial lighting in the business part of the city. The exhaust steam from the engines driving the generators is used for heating.—*Am. Elec.*, May.

ELECTRO-PHYSICS AND MAGNETISM.

Bodies Smaller than Atoms.—J. J. THOMSON.—An abstract of a discourse held before the Royal Institution. He followed the same lines of argument as in his Brit. Assn. address of 1899. He put forward his views as to the actual existence of positive and negative electricity, the positive electricity being variable and the negative invariable, which is in a way a return to the old fluid theory of electricity. He explained the experiment he had made to determine whether the mass of the electrified ions was or was not of electrical origin. He led a stream of cathode rays into an alternating electrostatic field so that the stream impinged on two targets, one of lead and the other of aluminum. If the mass were of electrical origin, less heat would have been developed at the aluminum than at the lead target, owing to the relative transparency of the former, but by careful measurements in a tube in which one target was replaceable, so that the differences between observations should be observable when one target was lead and the other aluminum, and when both were of the same metal, the heat generated in the two cases was identical within the limits of accuracy of his experiment.—Lond. *Elec.*, April 26.

REFERENCES.

Analyzing Wave Forms.—WOODHOUSE.—A communication, illustrated by a diagram, in which he describes a simple graphical method for determining the constants in the Fourier series by which a given periodic function is to be expressed.—Lond. *Elec.*, April 19.

Properties of Metals and Alloys.—GUILLEAUME.—A long article, in which he gives a summary of recent researches on the electric and thermic conductivities, specific heat, temperature of fusion and dilution at higher temperatures.—*L'Ind. Elec.*, April 10.

Windings for Electromagnets and Solenoids.—An article giving the essentials in the determination of windings for electromagnets and solenoids, together with three comprehensive tables, which reduce the mathematical operations to a few arithmetical computations. —*Am. Elec.*, May.

ELECTRO-CHEMISTRY AND BATTERIES.

Accumulator Tests.—A summary of the set of rules for the second international competition of storage batteries to be held in 1901-2 under the direction of the Automobile Club of France. The tests will commence with the beginning of June and will extend over a period of one year. Each competing battery, composed of a suitable number of elements, and contained in a "cell," to which it can be easily fitted, must furnish practically 120 ampere-hours without its p. d. falling below 8.5 volts at a current of 20 amperes. The batteries must come under one of two heads: First, batteries of high specific capacity and low rate of charge; maximum weight, 60 kilos; second, batteries of low specific capacity and high rate of charge, maximum weight 90 kilos. The trials will be made for periods of 6 days, alternating with one day rest. During these six days, the batteries will be submitted for periods of five hours, by means of an automatic apparatus, to vibrations as in ordinary automobile practice on the road. During these five hours the batteries, connected in series, will send discharging currents of various strengths, according to a certain diagram, as in the first test mentioned in the Digest two years ago (2 minutes 20 amperes, then a half minute 100 amperes, 3 minutes 50 amperes, 2.5 minutes 40 amperes, 3 minutes 70 amperes, 5 minutes 30 amperes, 4 minutes 20 amperes, 10 minutes no load). This varying discharge, to be obtained by means of a commutator rotating once in 30 minutes, is to be reproduced ten times in succession, each complete cycle corresponding to 12 ampere-hours. On the last day of the competition the batteries will be discharged at a constant output of 24 amperes for 5 hours. Charging will take place at 12.5 volts.—*The Electroch. and Met.*, April.

Accumulators.—JOHN H. WEST.—A continuation of his article on recent progress in accumulator manufacture. He gives some large tables, containing quite an amount of valuable information, giving comparative data of a number of cells, chiefly those exhibited at the late Paris Exposition and those participating in the Automobile Club competition of 1899. For each cell of a certain capacity data are given for three types, relating to 10-hour, 5-hour and 1-hour discharge. The capacities are 25, 50, 100, 200, 400, 800, 1500, 3000 and 6000 ampere-hours. The data given are the weight of electrodes per ampere-hour in grams. The total weight per ampere-hour in grams; the volume per ampere-hour in cub. cm.; the discharge rate in ampere per k. g. of plate; the price per ampere-hour in pence. A curious point brought out by the tables is that the mean density of a complete cell measured over all is only about twice that of water.—*The Elec. Chem. and Met.*, April.

Allotropic Forms of Silver.—BERTHELOT.—There are four allotropic states of silver, viz., silver modified by the action of oxygen at 550 degs., silver precipitated by copper and not heated, the same heated afterwards, and crystallized silver. Whenever one of these varieties is opposed to another in an electrolytic cell containing a 10 per cent solution of silver nitrate, a current is generated, amorphus sheet silver being positive with respect to the other varieties. Since the amorphus variety has the greatest heat of oxidation, its electro-chemical behavior is just what one might expect. The current never lasts more than five minutes. At the end of that time the surfaces of the two electrodes are equalized by the deposition upon the cathode, of the particular allotropic variety of silver of which the anode consists. Certain irregularities to which the electroplating process with silver is subject, are probably due to these allotropic states.—*Comptes Rendus*, March 25; abstracted in Lond. *Elec.*, April 19.

Carbon for Electro-Chemical Purposes.—An article on "Carbon in electro-chemical operations." The conclusion is arrived at that for the wet electrolysis of the chlorides of the heavy metals or alkalies, retort carbon or artificial graphite carbons are most suitable; for chromium reducing ordinary artificial carbon, the raw materials of which have been carefully purified, and for calcium carbide artificial carbons made out of ordinary, not purified, materials.—*The Elec. Chem. and Met.*, April.

REFERENCES.

Decomposition Voltages.—BANCROFT.—A description of a simple laboratory apparatus for determining the voltage required for the decomposition in an electrolytic cell. The cell is in series with an ammeter and a source of e. m. f. Across the terminals of the cell a high resistance voltmeter is connected. By means of a variable resistance the e. m. f. at the terminals of the cell is gradually increased.—*Jour. Phys. Chem.*, Feb.

Electrolytic Deposition of Copper.—SAYER and SPIERS.—The first part of an article in which they propose to discuss some small but important details in the electrolytic deposition of copper. This part deals with "corrosion," i. e., the local action by which copper is dissolved in the electrolyte.—*The Elec. Chem. and Met.*, April.

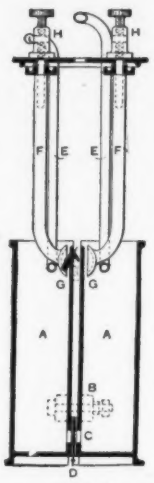
Estimation by Electrolysis.—NATHAN.—The conclusion of his article. He gives a brief review of the various methods of electrolytically separating different metals from another, and gives brief suggestions on the separation of copper, cadmium, iron, cobalt and nickel, gold and lead, from other metals. The article is concluded by brief notes for the estimation of several alloys.—*The Elec. Chem. and Met.*, April.

Electrolysis in Organic Chemistry.—HEWITT.—A continuation of his article on applications of electrolysis to organic compounds. This part deals with halogen derivatives of fatty hydrocarbons.—*The Elec. Chem. and Met.*, April.

Electro-Chemical Laboratory.—SMITH.—An illustrated description of the installation of the electro-chemical laboratory of the University of Pennsylvania.—*Science*, May 3.

UNITS, MEASUREMENTS AND INSTRUMENTS.

Improved Caldwell Interrupter.—RUHMER.—To obviate the disadvantages attending the wearing out of the perforated wall in the Caldwell (or Simon) interrupter, he uses the arrangement shown in the adjoining figure. The electrolytic vessel is divided into two semi-cylindrical portions *A A*, joined by means of screws *B*, and communicating through a narrow channel *C*, which is further narrowed by the introduction of a perforated porcelain plate *D*. The electrodes *F F* are of lead, having the terminal portions *G G* widened out so as to nearly cover the channel *C* when let down into position. They are kept cool by the circulation of water through *E E*.—*Der Mechaniker*, 1901, No. 6; abstracted in Lond. *Elec.*, April 26.



SIMON INTERRUPTER.

Testing Electric Light Networks.—CHARPENTIER.—A brief abstract of a pamphlet in which he suggests a method of testing and localizing faults in electric lighting networks, which is a development of the Agthe and Kallmann test-wire system, combined with the loop system, as applied to this class of networks. He proposes to add between the two external layers of insulation of the cable, a wire spiral with a short pitch. If the cable is damaged this spiral wire will be earthed, as there is only a thin layer of insulation between it and the lead, and a continual test of it will reveal any faults. These wires are to be connected up among themselves in the same way as the working conductor of the cable, and an additional telephone wire is to be laid alongside to form an insulated return for the loop test and to facilitate communication with the station while testing outside. That journal adds: "We do not think that Mr. Charpentier's system will work as well as he anticipates. As a means of insulation testing it has the disadvantage of leaving out of account the consumer's wiring, and there would be various sources of difficulty and error in applying it for fault localization. These might perhaps be overcome, but we think that the sysem will hardly receive general application."—Lond. *Elec.*, April 19.

REFERENCES.

Meters.—JANET.—A reprint in full of his very long paper on the meters exhibited at the late Paris Exhibition, an abstract of which was noticed before in the Digest.—*Bull. de la Soc. Int. des Elec.*, Feb.

The Construction of an Electrodynamometer.—KINTNER.—A didactic article on the construction and calibration of an electrodynamometer for students and amateurs.—*Am. Elec.*, May.

A Simple Method of Locating Short Circuits Between Electrical Conductors.—ROE.—An article with diagrams showing how to lo-

cate short circuits in concealed electric conductors by means of an exploring coil, a telephone receiver and a battery of 3 to 8 cells, connected through an interrupter to the faulty circuit.—*Am. Elec.*, May.

TELEGRAPHY, TELEPHONY AND SIGNALS.

Loud-Speaking Radiophone.—TOMMASINA.—A description of an electric radiophone which can be heard throughout a large hall. No relay is used, and the receiver is simply in circuit with a battery and a telephone. In the coherer he uses silver filings mixed with lycopodium, sulphur or glass powder, and embedded in glycerine. The electrodes are platinum coils wound on glass. Electric waves impinging upon this coherer produce an increase of resistance which, however, only lasts as long as the impact lasts. The coherer is therefore "self-righting," and to such an extent that the author declares it to be an interrupter controlled by electric waves.—*Comptes Rendus*, March 11; abstracted in Lond. *Elec.*, April 19.

REFERENCE.

Common Battery Telephone Systems.—HENRY.—Another of his series of articles on the common battery system, this one dealing particularly with the system used by the Bell Company.—*Am. Elec.*, May.

MISCELLANEOUS.

Blaze Currents as a Sign of Life.—WALLER.—A description of an electrical method for estimating the vitality of seeds. It is based "upon the blaze currents" discovered by him and first described in connection with a frog's eyeball. A "blaze current" is a galvanometrical token of an explosive charge locally excited in living matter. It may be a current in the same direction as the stimulating current, or in the opposite direction. In the latter case it is equivocal, as it cannot be distinguished from a counter-current due to polarization. It is, therefore, the direct current that the author relies upon as a criterion of life. The proof that the criterion is a true one, is furnished by the author's experiments on beans of various ages. Beans not more than a year old all show blaze currents, and all germinate vigorously in the incubator. Seeds grown in 1860 show no perceptible blaze currents, and do not germinate. New seeds show only half the e. m. f. of blaze currents (i. e., about 0.02 volts) after three days' soaking in water, and none after four weeks' soaking. Anæsthetics and cold also influence the blaze currents and the germination in a parallel manner. It is evident that the author has discovered a test which enables us to satisfactorily distinguish between living and dead matter.—*Proc. Roy. Soc.*, March 25; abstracted in Lond. *Elec.*, April 19.

Smelting Iron Electrically.—An article on the question whether the smelting of iron by electricity is practicable. This question is of the greatest importance for countries which are rich in iron ore, but not in fuel. It is pointed out that a certain quantity of energy is required per pound of iron oxide, to separate the oxygen from the iron. It is calculated that with an ideal electrical process of smelting iron, in a year of continuous day and night working, one horse-power could produce 2¾ tons of iron. The coke required to make 2¾ tons of iron in the blast furnace is worth at present about $5.50, while a 24-hour horse-power of electric energy for a year is worth anywhere from $20 upwards. The conclusion is, therefore, that a process of electric iron smelting under the most favorable circumstances would be several times as great as the cost of the present method of reduction of iron by the combustion of fuel in the blast furnace.—*Eng. News*, May 2.

REFERENCES.

Atomic Weights.—A reprint of a table of "international" atomic weights, just issued by the German Chem. Soc. It is based upon *O* equals 16.—*The Elec. Chem. and Met.*, April.

Paris Exposition.—An illustrated description of the Worthington pumping installation, supplying water to the fountains.—*St. R'y Jour.*, Int. Ed., May.

New Book.

RESEAUX ELECTRIQUES. Nouvelle Methode Generale de Controle de l'Isolement et de Recherche des Defauts sur les Reseaux Electriques Pendant la Service. Par Paul Charpentier. Paris: Ch. Beranger. 23 pages, 6 illustrations. Price, 2.50 francs.

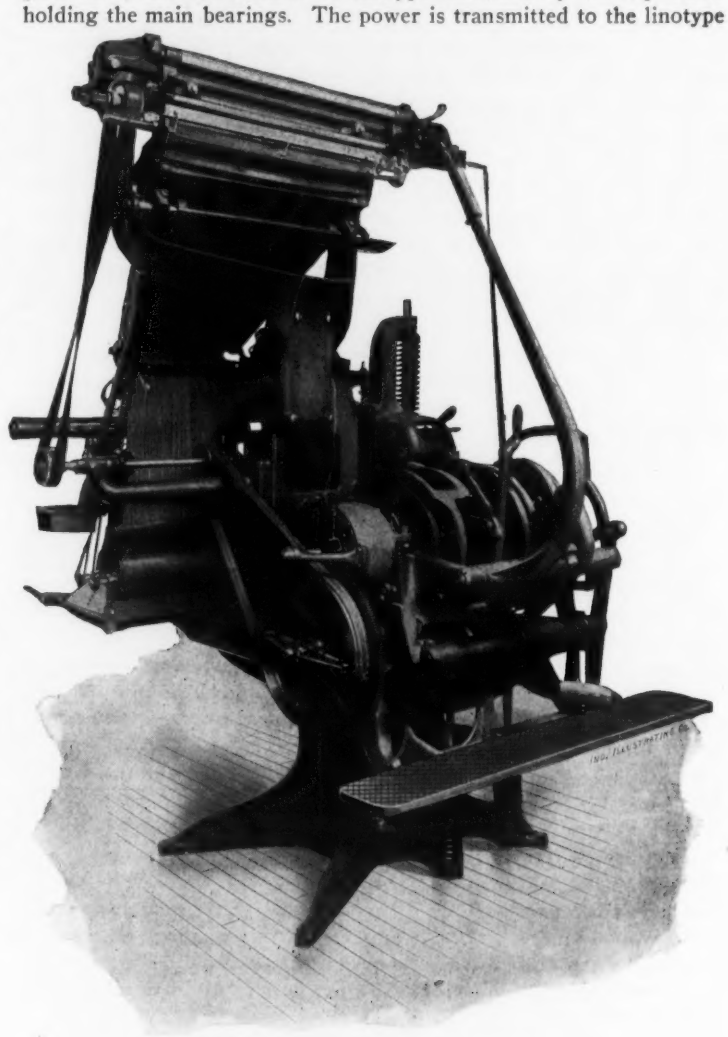
In this brief essay the author brings forward another method to be added to the many already devised for locating faults in systems of electrical distribution. The system proposed consists in installing alongside of the distribution network another network formed by a special arrangement of controlling wires; the idea being that every defect developed in the former system is reproduced equally in the second system. In addition, it is intended that in this system, grounds should be produced on the controlling system before developing on the actual distribution network. Both systems are entirely insulated, one from the other, and only come in contact at a single point at most after the development of a fault or in case of a short circuit The result is that with this set of conditions, if a fault develops it is located, not by the distribution network, but on the controlling network which follows it in close juxtaposition.

In the case of an insulated lead-covered cable, the author proposes to run a bare wire between the insulated core and the lead sheath. The defects would therefore manifest themselves on the bare pilot wire before reaching the conducting core in most instances.

The actual work of testing out in this system requires that communication be had between the central station and the tester out on the lines, this being accomplished, either by telephone or by bell signals. We consider the latter requisite the weak point in the system, and while the principles laid down are no doubt correct and workable, the methods now generally employed would appear to bring about the desired results more expeditiously and probably with quite as great a degree of accuracy in location, while involving less complication.

Jenney Linotype Motor.

The accompanying cut illustrates the special type of motor built by the Jenney Electric Manufacturing Company, of Indianapolis, Ind., for driving linotype machines. These motors are of very compact form, and are secured to linotype machines by the cap screw holding the main bearings. The power is transmitted to the linotype



LINOTYPE DRIVEN BY ELECTRIC MOTOR.

through an accurately cut pinion on the armature shaft that engages with a clutch gear wheel substituted for the belt-clutch pulley.

These motors have been used by several newspapers for about two years, and have given the best of satisfaction. The Jenney Company has just completed the installation of 37 of these motors at the Chicago *Tribune* office, having, it is stated, secured this order after a competitive test for efficiency and general results with seven different motors.

Automobile Exhibits at the Pan-American.

The exhibit of the Electric Vehicle Company at the Pan-American Exposition will be the largest in the number of vehicles and most complete in the varied assortment of styles of any single display made at an exposition in this country or abroad. In all, there will be 31 automobiles of the well-known "Columbia" and "Riker" types in the company's enclosure in the transportation building and several others in practical demonstration about the Exposition grounds. Of the Columbia vehicles on exhibition there will be the following: One phaeton, one tricycle carrier, one gasoline runabout, one wagonette, one six-passenger omnibus, one runabout with wooden wheels, one runabout with buggy top and wire wheels, one Victoria with wire wheels, one Victoria with canopy top and wooden wheels, one extension front brougham, one surrey, one cabriolet, one rear-boot Victoria, one delivery wagon. The Riker list includes one piano-box runabout, one Victoria, one phaeton, one spider phaeton, one mail phaeton, one Victoria De Luxe, one delivery wagon, one two-ton truck, one Wilkesbarre bus, one theater bus, one public hansom, one railway cab, one straight front brougham, one demi-coach, one brake, one gasoline voiturette.

Both the Columbia and the Riker type are familiar sights in all the large cities throughout the country. Many of them are in use in Canada and Mexico, and more than a hundred have been shipped to England, France and Germany. In Buffalo, by the operation of the New York Electric Vehicle Transportation Company, the merits of Columbia vehicles are well known. A Columbia delivery wagon is under contract to carry the mail between the Buffalo Post Office and the Pan-American grounds, and several vehicles of a smaller type will be used to distribute mail about the Exposition grounds.

Another Columbia delivery wagon has recently been purchased by the Government for the distribution of books from the Congressional Library at Washington. Five active fields of service are included within the range of usefulness of the Columbia and Riker vehicles on exhibition, namely, ordinary pleasure riding about city and suburbs, long-distance touring and cross-country work, transportation by means of conveyances, with large seating capacity, delivery service for the department stores of large cities, and similar concerns and heavy trucking work.

The pleasure vehicles to be exhibited include runabouts phaetons, Victorias, surreys and cabriolets. Vehicles of this type are equipped with new long-distance batteries, which have a running capacity of 40 miles on one charge.

Storage Battery Tests.

An interesting test was recently made with a light electric runabout, using a set of U. S. storage cells. The vehicle was one in which another type of storage battery had been used, and for which the makers claimed a maximum distance of 20 miles on one charge. The U. S. battery installed was of the same weight as the old battery. A run was made over the roads around Brooklyn, taking hills and rough places as they came, and yet 50 miles were covered without the slightest difficulty. At the end of the run it was necessary to climb a 10 per cent grade, which showed that the batteries were not entirely exhausted.

Another set of U. S. storage cells has been in daily service in a four-passenger vehicle for three months, during which time no cell has had to be opened or repaired in any way. The wagon has been used around the city streets, and the batteries are asserted to be stronger to-day than when they were new. These tests are evidence in support of the claims made for the battery as to durability, efficiency and capacity.

The cell is not a lead battery, but made on new lines, and has been put to severe tests on other work under the most practical conditions. In smaller compass it is being used on fire alarm telegraph service very successfully.

Its construction is such, it is said, as to entirely overcome such defects as buckling, short circuiting, creeping of salts over the edge of cell, current leakage and excessive evaporation of electrolyte. It is manufactured by the United States Battery Company, of 253 Broadway, New York City, and a large sale for this new type of storage battery is predicted.

Spherical Coil Wattmeters and Phase Indicators.

As is well known, on an alternating-current circuit the product of the voltmeter and ammeter readings does not give the true watts unless the circuit is non-inductive. This is a condition never attained where there are transformer and motor loads, in the latter case the discrepancy sometimes reaching 50 per cent. On the other hand, a properly constructed wattmeter indicates the actual delivery at a glance. The accompanying illustration shows a wattmeter

FIG. 1.—SPHERICAL COIL WATTMETER.

constructed for alternating-current service, and based upon the dynamometer principle, which permits of absolutely correct readings of alternating-current power. A movable coil attached to the pointer is suspended within the field of a fixed coil. The fixed coil carries the main current of the circuit and through the movable coil the pressure is taken. The winding of the fixed coil is of a hollow spherical form from which the instrument takes its name. The movable coil and pointer are delicately suspended in jeweled bearings, and their motions are dampened by an air dash-pot, making the instrument dead-beat. It is not affected by frequency or wave form, nor by inductive or leading loads of any power factor. It is equally available and efficient for direct-current work and is reported most satisfactory under all circumstances. With a resistance of approximately 30 ohms per volt in the pressure circuit the spherical coil wattmeter is of remarkable efficiency.

Station instruments of 150 amperes or less capacity and for use on circuits of less than 5500 volts have the resistance self-contained in their cases, and the total current is introduced into the fixed coil. With instruments of a greater capacity or for use on circuits of a higher voltage than this, series transformers are regularly provided. If instead of the instrument taking the total current through its fixed coil, the series transformer is used, it must be calibrated on

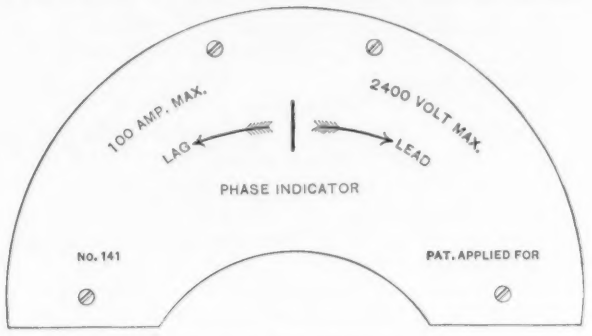


FIG. 2.—PHASE INDICATOR.

the frequency for which it is intended, as the introduction of a series transformer makes the instrument subject to frequency errors. A special adjustment is also made in the instrument for use with a series transformer, which compensates for any change in the phase relations, making the instrument correct on inductive loads.

Potential transformers, regularly furnished for voltages over 1200, have standard ratios, the resistance for the secondary voltage being self-contained in the instrument case. Sufficient series resis-

tance for any voltage, however, can be furnished if desired and specially requested. A feature of these instruments, worthy of special mention, is that they have practically the same case and base as the well-known type of S. K. C. hot-wire ammeters and volt-

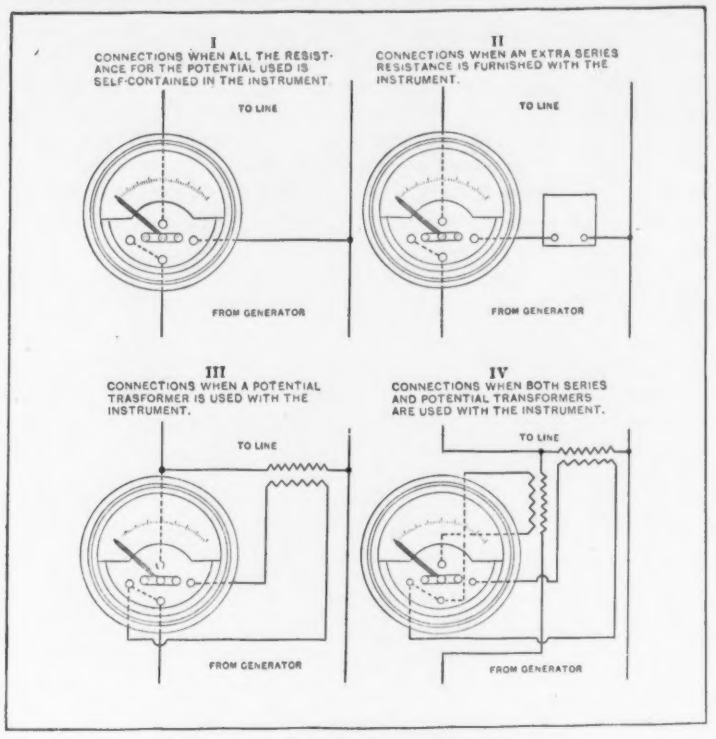

I
CONNECTIONS WHEN ALL THE RESISTANCE FOR THE POTENTIAL USED IS SELF-CONTAINED IN THE INSTRUMENT.
TO LINE
FROM GENERATOR
II
CONNECTIONS WHEN AN EXTRA SERIES RESISTANCE IS FURNISHED WITH THE INSTRUMENT.
TO LINE
FROM GENERATOR
III
CONNECTIONS WHEN A POTENTIAL TRASFORMER IS USED WITH THE INSTRUMENT.
TO LINE
FROM GENERATOR
IV
CONNECTIONS WHEN BOTH SERIES AND POTENTIAL TRANSFORMERS ARE USED WITH THE INSTRUMENT.
TO LINE
FROM GENERATOR

FIG. 3.—DIAGRAMS OF CONNECTIONS.

meters of the same make; that is, a rubber base-plate set in a brass rim, rubber cylinder for the sides, spun brass cap and beveled plate-glass front. They are insulated for extremely high potentials and may be subjected to pressures as high as 10,000 volts between case and working parts without danger.

The S. K. C. phase-indicating instrument, shown in Fig. 2, is a modified spherical coil wattmeter, having its zero in the center. Two arrows pointing to the right and left, respectively, take the place of the wattmeter scale.

Disturbances, due to a heavy lagging or leading load on a line having connected to it synchronous motors, can be counteracted by varying the field current of the synchronous motors. Synchronous motors take a lagging current if under-excited and a leading current if over-excited. At one point in their excitation the current taken is in phase with the impressed e. m. f. In order to determine the most desirable excitation of a synchronous motor, it is necessary therefore to be able to ascertain the condition of the phase relation of current and e. m. f. of its circuit.

The phase indicator shown gives correctly and at a glance just this information. The pointer deflects to the left if the current lags behind the e. m. f., remains at zero when the current is in phase and deflects to the right if the current leads the e. m. f. For situations where motors are being run from the same machines which supply the lighting load it is obvious that such an instrument is of great value, as by its indications the point of proper excitation of the synchronous motors is quickly and exactly determined, and thus the regulation of the whole system is materially increased.

The instrument depends for its action upon the principle that no force is exerted betwen two coils carrying currents 90 degs. apart. Hence, if we take a wattmeter and introduce in its fixed or series coil a current, and through its movable or pressure coil another current differing in phase with the series current by 90 degs., the pointer will stay at zero. If, however, the current in the series coil should change its phase relation to that in the pressure coil by more than 90 degs. the pointer would deflect to the left, indicating a lag. If less than 90 degs. a deflection to the right would result, indicating a lead.

Fig. 3 shows the manner in which the instruments are connected in circuit. In instruments designed for operation on single phase systems, the pressure is taken directly into the instrument by means of step-down transformers or series resistance. The pressure circuit in the instrument is made completely inductive, the current through the pressure coil lagging 90 degs. In two-phase systems the pressure is taken from one phase and the current from the other. The pressure is introduced by means of a transformer and the instrument circuit is non-inductive and has no capacity. With three-phase circuits, two of the pressures are compounded and the 90 degs. lag between the series coil and the e. m. f. is thus secured.

Variable Speed Motor Drive for Engine Lathes.

The accompanying illustrations show a Commercial double commutator motor direct geared to a heavy pattern engine lathe. By a specially constructed saddle casting, the motor is mounted upon the standard head stock casting, thus requiring no changes in the lathe patterns. By the system of gearing used, the motor drives a simple sleeve that replaces the ordinary step pulley or cone in the head stock of a belt driven lathe. The motor is of the semi-enclosed type, is very compact, and so arranged that the greatest torque is secured at the lowest speeds. By means of various combinations of motor windings and gearing, 12 different speeds of the spindle are secured, ranging from 2½ r. p. m. to 450 r. p. m., without the use of any resistance in the armature circuit of the motor, so that there is no waste of electric power when running at slow speed; and when set to a given speed, that speed remains practically constant.

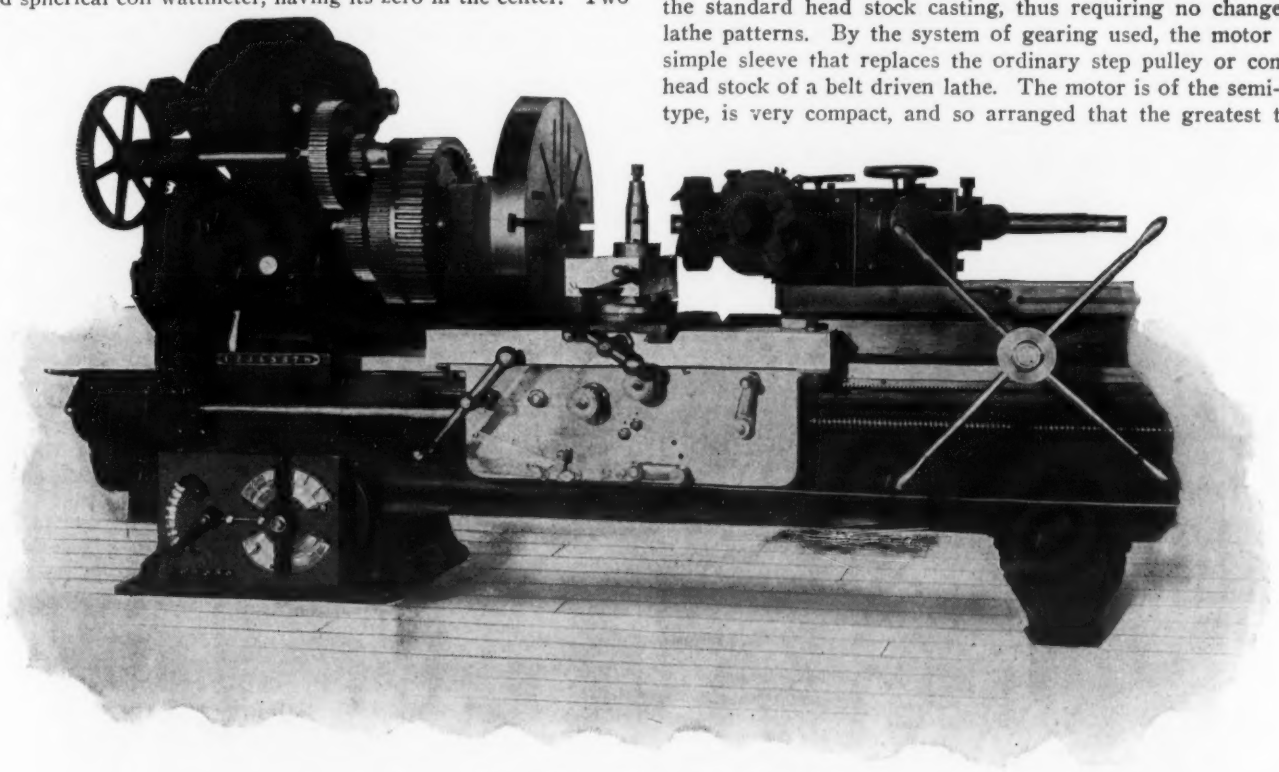


FIG. 1.—MOTOR DIRECT-GEARED TO ENGINE LATHE.

The starting and stopping of the lathe is accomplished at the apron

of the lathe carriage. The controller is constructed with an interlocking mechanism that makes it impossible for incorrect combination of the circuits to be made, or for the motor to be started without the speed governing lever being locked in its correct position. By the use of this motor system, heavier cuts can be taken and more

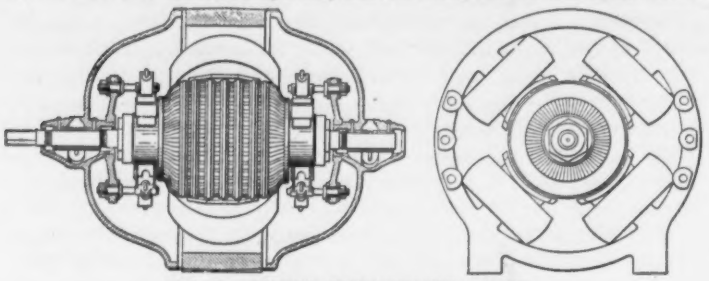


FIG. 2.—DOUBLE COMMUTATOR MOTOR.

work can be done in a given time than by the ordinary speed lathe, for the reason that the capacity of the lathe is limited by the driving power of the belt, which is practically found inadequate for the work that other parts of the lathe could easily perform.

By the elimination of all belts and shafting, this lathe may be placed in any desired position in the shaft with regard to location of the main driving shaft, and may be placed directly beneath a traveling crane, with the operation of which a belt driven lathe in a similar position would interfere. Experience has demonstrated that the operation of this tool has increased the production of one class of work 35 per cent over that of the same lathe driven by belt, and that at the same time, considerable saving in power has been effected.

Movable Coal Conveyor of the Chicago Edison Plant.

Where coal is brought to the consumer in gondola cars, the cost of unloading is a serious item. This is especially true where several cars per day must be unloaded. The Robins Conveying Belt Company has offered two solutions for this problem, both of which can be seen in operation in Chicago. The first installation was at the power plant of the South Side Elevated Railroad, where fixed conveyors were built alongside the railroad track. Running in opposite directions, they both deliver the coal into the same hopper from which it is fed into a cross conveyor and carried into the storage bins. A more novel arrangement is that at the Harrison Street station of the Chicago Edison Company. Here, fixed conveyors could not be considered, as it was necessary to keep the yard clear for the handling of machinery. To meet these conditions the Robins Company built the machine, which is herewith illustrated, Figs. 1 and 2. The conveyor is mounted on a movable frame work, which is 90 ft. long and about 4 ft. high, and supported on three sets of wheels, which run on a narrow-gauge track. One electric motor serves to drive the conveyor and also to move the entire machine forward and backward. The method of using the conveyor is clearly illustrated by the half-tone and diagram, the dotted lines in the latter showing that the coal from six cars can be carried to a common point without its being necessary to shift the cars.

Apart from the convenience and economy of space gained by this arrangement, there must also be noted the large capacity and the small expenditure of power. This point is brought out by the following figures, which are the results of tests made by the engineers of the Edison Company: To drive the conveyor running empty requires 3¾ hp; to drive it when it is loaded by 14 men scooping from the cars at the rate of 67½ tons per hour, 4⅛ hp is required, and to move the entire apparatus, takes 5⅛ hp.

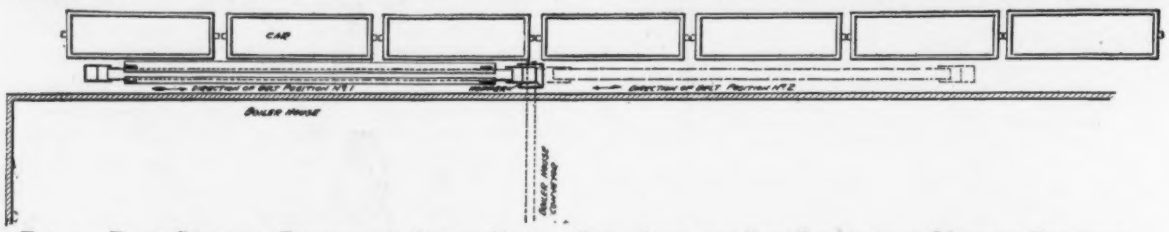


FIG. 1.—PLAN SHOWING POSITION OF BOILER HOUSE, COAL CARS AND TWO POSITIONS OF MOVABLE CONVEYOR.

From the diagram, it will be seen that when the conveyor is moved to the second position the direction of the belt's motion is reversed. This is accomplished with a reversing switch at the motor. To move the frame along on its track, power is communicated to the driving wheels through a friction clutch at the end of the conveyor furthest from the motor; the conveying belt being used to transmit the power. This conveyor was built under the supervision of Messrs. Sargent & Lundy, consulting engineers of the Chicago Edison and other electric companies.

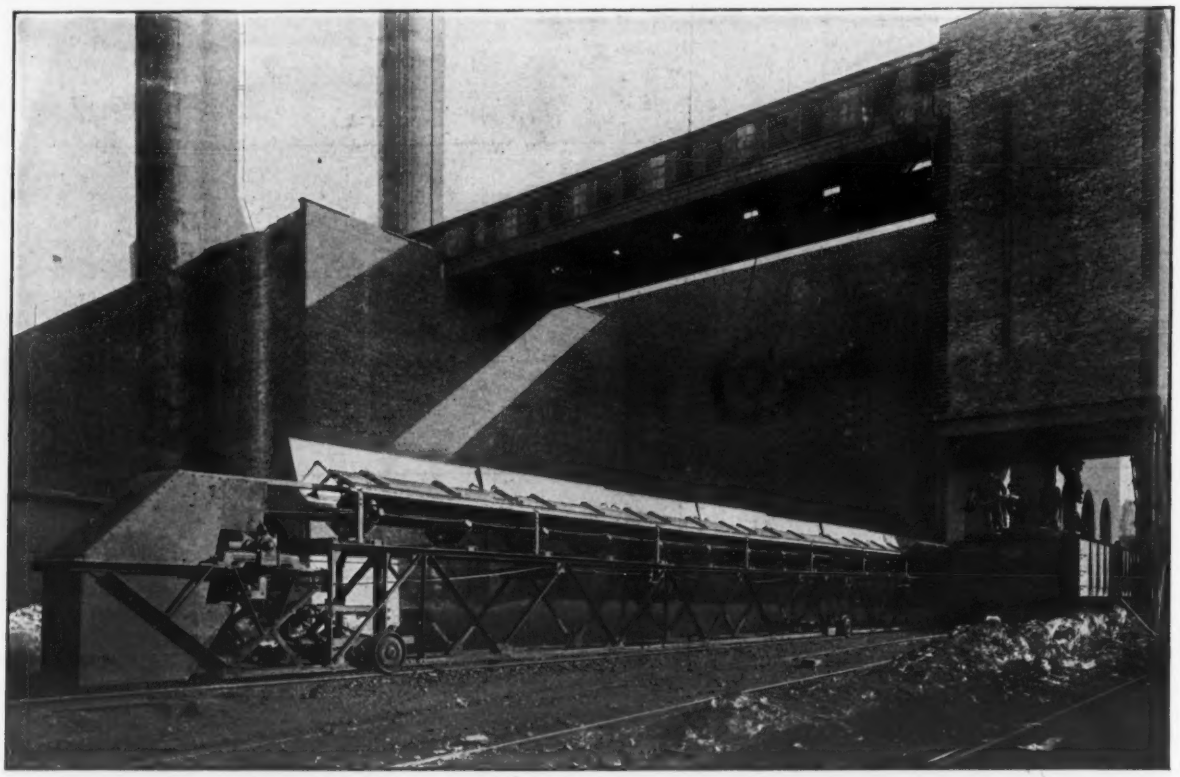
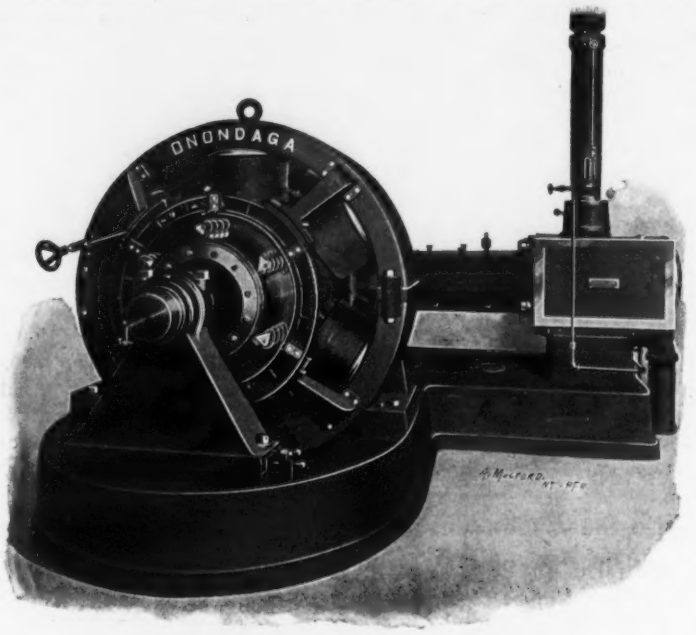


FIG. 2.—GENERAL VIEW OF MOVABLE COAL CONVEYOR.

A Pan-American Installation.

The Onondaga Dynamo Company, of Syracuse, N. Y., has made a very pretty and effective installation in the court in the Machinery and Transportation Building at the Pan-American Exposition. It is herewith illustrated. The unit shown comprises a 75-kw Onondaga generator direct connected to a straight line engine, all on one base,

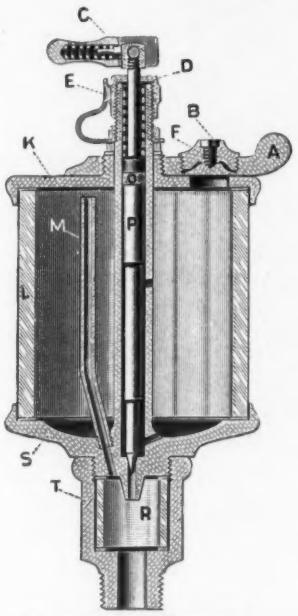


A COMPACT UNIT AT THE PAN-AMERICAN.

and constituting a remarkably compact plant, as handsome as it is efficient. This plant is employed to light the buildings and also to furnish current for some of the electric lighting displays that form one of the most striking beauties of the show at Buffalo.

Gas Engine Lubricator.

The form of gas engine lubricator shown herewith is manufactured by the Lunkenheimer Company, and designated by the trade name "Paragon." The filling arrangement consists of a screw-down slide filler. Referring to the sectional illustration it will be seen that the slide *A* screws down on and around the lid of cup and has a loose plug which covers the filling hole when the slide is swung over to a closed position. This loose plug is so arranged that its wear can be adjusted by turning down the screw *B*. The whole construction is heavy, and the slide can be depended upon to seat perfectly and remain tight for an almost indefinite period. On account of this construction it is possible to secure a large filling hole, which, as users know, is a desirable feature.



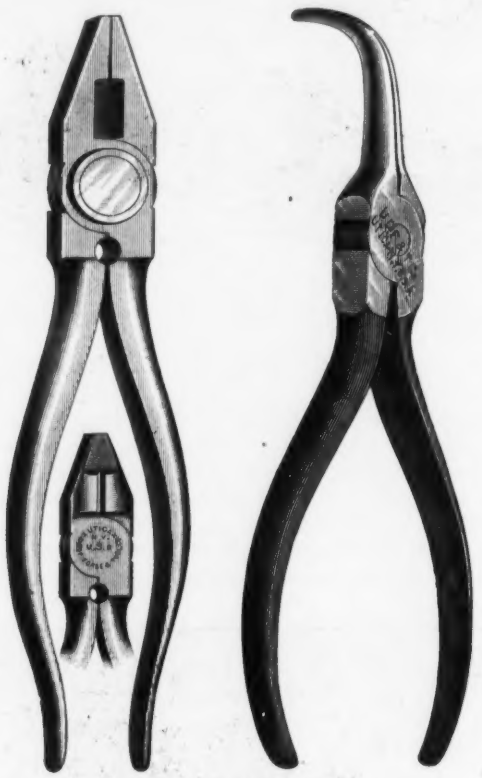
SECTION OF LUBRICATOR.

The feed can be put on or off by raising or lowering the cam lever *C*. The rate of feed can be adjusted by turning the nut *D*, which is prevented from loosening by the spring *E*. By this arrangement the reed can be set and turned on or off without disturbing the rate of flow. The cup is packed both around the stem and at the top and bottom of body and sight-feed glasses and cannot become leaky. The whole cup is secured together by a lock-nut construction which makes it impossible for the cup to jar apart, due to the shaking of the engine, and also dispenses with the annoyance of oil leaks. The sight-feed glass, *R*, is quite large and can be readily cleaned by unscrewing the upper part of the cup from the base piece.

New Pliers for Linemen.

We illustrate herewith a new roller rivet type of knot-tying and splicing side cutting plier made by the Smith & Hemenway Company, 296 Broadway, New York City. This is made in 6, 7 and 8-inch sizes. A feature of this tool is the grooved roller, ¾ inch in diameter, which revolves around the large pivot, and the splicing device directly underneath it. By this means a lineman is saved the carrying of one tool, viz., a splicer. In use, each end of the wire in turn is passed around the roller and twisted neatly around the main line, thus splicing a break or connecting two sections. The smaller cut is a view of the cutter side.

Fig. 2 shows the bent or curved nose plier of the same company.



FIGS. 1 AND 2.—PLIERS.

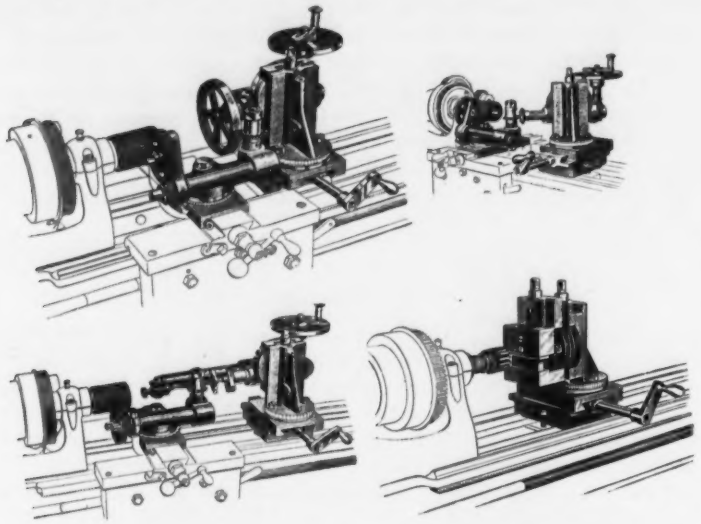
This is especially adapted, we are told, for electricians, machinists, textile mills, oculists and jewelers. The utility of this tool can be seen at a glance.

Universal Gear-Cutting and Milling Attachment for Lathes.

The accompanying cuts show a new attachment for lathes which will take the place of gear-cutting and milling machines for many kinds of work. It is designed for use by tool and model-makers, experimental and all workers desiring to do fine, accurate work. The bracket piece which contains the driving mechanism is attached to the cross-feed slide of the lathe in place of the regular tool block. The driving arbor which runs through this bracket piece transmits motion to the upright or cutter spindle by means of a pair of spiral gears which are encased so that they are free from dirt and chips. The driving arbor receives its motion from the head stock lathe spindle through a train of three spur gears, one of which is screwed onto the nose of the lathe spindle and has a wide face which allows a longitudinal travel of three inches for the cutters. Any of the regular change gears furnished with the lathe may be used for the other two driving gears, and by using different combinations a large number of speeds for the cutter may be secured. The intermediate gear is on an adjustable quadrant which swivels on the frame piece and allows a cross movement of the entire frame piece and slide rest and accommodates the cutters to the various sizes of work. The automatic longitudinal feed or the hand crank may be used to feed the cutter to the work.

The base of the swivel dividing head is securely clamped to the lathe bed by means of two bolts and a binder plate, and has cross and vertical feeds, which are operated by a hand crank. The up-

right part swivels on the cross-feed slide, which is graduated and renders it capable of fine adjustment to any horizontal angle. The frame piece containing the spindle, indexing mechanism and the overhanging arm swivels on the vertical feed slide which is graduated and allows fine adjustment to any vertical angle. By means of these



FIGS. 1, 2, 3 AND 4.—GEAR-CUTTING AND MILLING ATTACHMENT.

two feed adjustments and the cross and vertical feeds, cuts of any desired angle may be made.

For milling operations requiring a vise, the frame piece containing the spindle, indexing device and overhanging arm, is removed and the vise arrangement is attached to the vertical slide. This may also be swiveled to any angle. In using this vise arrangement, the milling cutters may be driven by the head stock spindle.

Chucks, centers, etc., may be used on both the head stock spindle of the lathe and the spindle of the swivel dividing head, as the taper holes and hose of both spindles are of the same size. Gears may be cut as large as the swing of the lathe. There is a complete index, and all numbers of teeth may be cut from 1 to 50, and nearly all numbers up to 360. Brown & Sharpe or any standard milling and gear cutters can be used. Figs. 1 and 2 show the attachment arranged for cutting spur, bevel or mitre gears, milling cutters, etc. Fig. 3 shows the attachment arranged for cutting flutes in taps, reamers, etc., and Fig. 4 shows it arranged for slabbing and various milling operations requiring a vise.

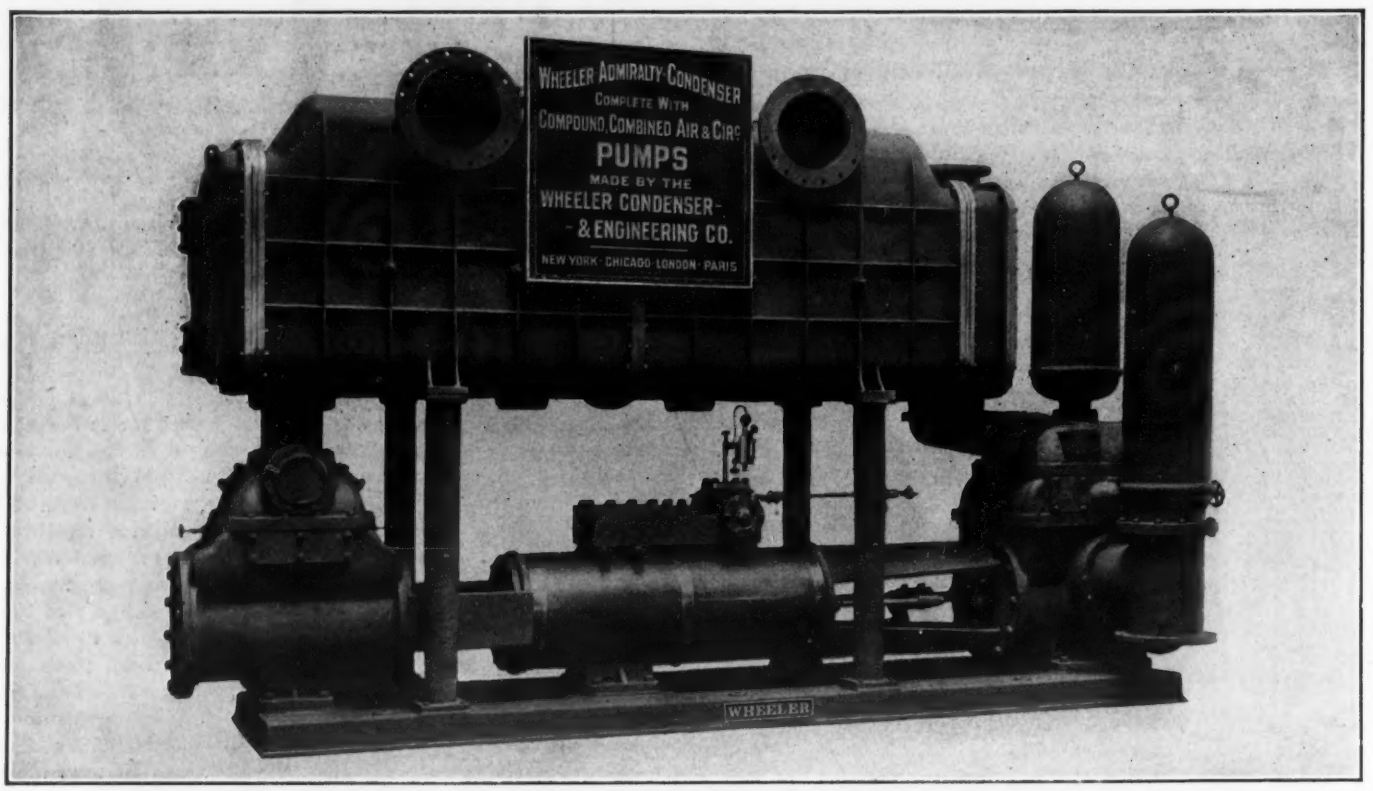
This attachment is designed by the Seneca Falls Manufacturing Company, Seneca Falls, N. Y., for use on their "Star" foot and power engine lathes, 9 to 13-inch swing.

Gas Engines in Automobile Works.

It is not generally known that the De Dion-Bouton Motorette Company, of Brooklyn, N. Y., employs gas engines as a source of power in its various departments. A large twin cylinder gas engine was installed when the factory was first equipped, over a year ago, and last week a smaller engine of 25 horse-power arrived. This machine will be fitted up at once, as the increasing business demands larger manufacturing facilities. The nickel-plating department has a little power plant of its own, consisting of a 3½-hp water jacketed De Dion motor, such as drives No. 1 type "motorettes." A standard "motorette" gasoline tank is placed above the motor, while the vaporizer occupies its usual position. The muffler is outside, it being connected to the exhaust port by a steel tube. A copper tube ⅝ inch in diameter connects the water port to the source of supply. The dynamo is driven at a speed of 1600 r. p. m. by a 3½-inch belt. The motor runs so steadily that no equalizing device is required, the fluctuations of the dynamo current being hardly perceptible. The whole nickel plating outfit is very interesting, as it shows a thoroughly practical application of the well-known De Dion motor.

Large Steam Condensers at the Pan-American Exposition.

Several of the features of the steam plant at the Pan-American Exposition will be of interest, in spite of the fact that the Exposition depends for much of its attractiveness upon the utilization of power transmitted from Niagara Falls. It is recognized, however, that a great many of the people who visit the Exposition have not got Niagara at their back and are interested in steam utilization. Moreover, Buffalo itself is one of the cities in this country where steam power is used most largely and economically.



GENERAL VIEW OF STEAM CONDENSER.

One of the steam exhibits at the Pan-American shown in Machinery Building is the Wheeler Admiralty surface condenser, herewith illustrated. It has been installed complete with compound combined air and circulating pumps. It is used in connection with 14 engines, aggregating not less than 2000 horse-power, thus constituting a demonstration of a large scale of work with surface condensers.

NEWS OF THE WEEK.

Financial Intelligence.

THE WEEK IN WALL STREET.—Early in the week quotations for money for call loans rose to 6@8 per cent, and later the figures fell to 2@3 per cent. It was not until Thursday, however, when the panicky condition of the stock market, caused by the Northern Pacific corner, became so acute that money advanced to an extreme figure. On that day money loans were called, and the demand for additions became urgent, resulting in 40 to 60 per cent being quoted on the Exchange. The severity of the pressure was relieved by the announcement that a number of bankers had combined to lend a large sum at the market rate. On Friday large sums were offered at 6 per cent, and the tone was eased, the extremes for the day being 3@13 per cent. Time loans were also affected in the same way, the quoted figures being 4½@5 per cent for 30 to 60 days, and 4½ per cent for longer arrangements. Commercial paper is quoted at 4@4½ per cent for double names. Last week was experienced the most sensational panic or break in stock values that Wall Street has ever seen, but at the close of the week the market had steadied and recovered part of its severe declines. The panic was due to the contest between two interests for the control of the Northern Pacific Railroad, and to the corner on the common stock of that road. Fortunately, on Friday the panic was checked by the action of a pool of 15 of the leading banking institutions in loaning $20,000,000 at the market rate, the price for money having rushed upward to 60 per cent on call on Thursday, as above noted. Speculators suffered heavy losses in the enormous decline of Thursday's market, which extended throughout the whole list and represented liquidation of contracts on a colossal scale. The recovery of the market from such conditions, however, was quick. Tractions and electric stocks suffered heavy declines with the general list. General Electric on Wednesday closed at 220, and on Thursday at 200, representing a net loss of 20 points in 24 hours. The highest quotation reached during the week was 229½, and the lowest 200, which point was reached on Thursday, the closing price being 220, representing a net loss for the week of 7¾ points. Brooklyn Rapid Transit lost 8½ points on Thursday, some of which was regained, the closing price being 77¼, a net loss of 6¼ points; the sales of stock were 126,700 shares, the extreme figures for the week being 85 and 68½. The highest price for Metropolitan Street Railway was 171¾, and the lowest 150, the closing price being 163, representing a net loss on the week's transactions of 6¾ points. This stock on Thursday dropped 14¼ points. Manhattan Elevated also suffered a severe loss on that day, dropping 38⅞ points. Western Union during the week passed par, reaching 100¼, and closed at 92½, a net loss of 4½ points. The most remarkable fluctuation in price in securities in the outside market was 180 points in Standard Oil, which, were it indicative of actual values, would represent a shrinkage of $180,000,000. The percentage of loss in other stocks was even greater. The recovery in Thursday's trading followed by further gains on Friday have left the general list at prices which show a decisive decline from the closing quotations of the week previous. Among the net losses were General Carriage, ⅝, and New York Transportaion 2⅛. Following are the New York and Chicago closing prices, quotations from Boston and Philadelphia not being reported:

NEW YORK.

	May 4.	May 11.		May 4.	May 11.
General Electric	227¾	220	Electric Vehicle	10	10
Brooklyn Rapid Transit.	83½	77¼	Electric Vehicle, pfd.	18	*24
Metropolitan Street Ry.	169¾	163	General Carriage	2¾	2¼
American Tel. & Cable	98	100	Illinois Elec. Veh. Tran.	¾	⅞
Western Union Tel.	97	92½	Hudson River Tel.	120	120
American Dist. Tel.	40	40	N. E. Elec. Veh. Tran.	2¾	2¾
Commercial Cable	185	186	N. Y. Elec. Veh. Tran.	4¾	2¾
Electric Boat	18	17	Tel. & Tel. Co. of Am.	5	*6½
Electric Boat, pfd.	45	43	N. Y. & N. J. Tel.	162	160
Electric Lead Reduc'n	4½	—			

BOSTON.

	May 4.	May 11.		May 4.	May 11.
New England Telephone.	—	—	Erie Telephone	59	—
Mexican Telephone	2⅛	—	General Electric, pfd.	—	—
Westinghouse Electric	—	—	Am. Tel. & Tel.	176½	—
Westinghouse Elec., pfd.	—	—	Boston Electric Light	240	—

PHILADELPHIA.

	May 4.	May 11.		May 4.	May 11.
Electric Storage Battery.	67	—	Philadelphia Electric	6¼	—
Elec. Storage Battery, pfd	74	—	Pa. Electric Vehicle	1¼	—
Elec. Co. of America	8¼	—	Pa. Elec. Veh. pfd.	1	—
General Electric Auto.	—	—	Am. Railways	43½	—

CHICAGO.

	May 4.	May 11.		May 4.	May 11.
Chicago Edison	171	170	Chicago Telep. Co.	250	—
Chicago City Ry.	250	—	Union Traction	15	14½
National Carbon	15¾	15¾	Union Traction, pfd.	56½	56
National Carbon, pfd.	85	83⅞	Northwest Elev. Com.	40	—

*Asked.

ELECTRIC RAILWAY COMBINATION.—Plans have been perfected for the absorption of the American Railways Company, and the Electric Company of America. Both corporations are Philadelphia enterprises; the former operating entensively in railways in the West and New Jersey, and the latter controls electric-light plants of Atlantic City, Altoona, Scranton and other Pennsylvania towns. The American Railways Company has full paid capital, $3,000,000, and Electric Company of America, $20,337,050 outstanding, on which $7.50 per share has been paid. The plan is for the formation of a new company, with increased capital to take over these concerns issuing its bonds and stocks therefor. American Railways is to be taken on basis of $55 per share and Electric Company of America 11½ per share.

CHICAGO EDISON.—Notices have been mailed to the stockholders of the Chicago Edison Company that at the annual meeting to be held June 10, a proposition to increase the authorized capital stock to $10,000,000 will be submitted to vote. The new stock is to be issued from time to time, as the directors shall decide that additions to the company's plant are necessary. The annual report of the company shows: Gross earnings, $2,517,219; operating expenses, $1,614,260; net earnings, $902,958; interest, $279,791; dividends, $477,688; total charges, $757,479; surplus, $145,479. The report of the sub-organization, the Commonwealth Electric Company, showed gross earnings of $629,046, against $517,131, and a net of $218,870, against $177,961, an increase of $40,909.

CHICAGO ELEVATED ROADS.—Consolidation of the Chicago elevated traction companies is in progress and will be perfected soon. Leading officials and financiers representing the Northwestern Elevated, Lake Street Elevated, Metropolitan Elevated, South Side "L," and Union Loop are working on the plans in New York City. Efforts have been made for some time to merge the associated interests controlling the Northwestern, and the Lake Street elevated lines and Union Loop with the Metropolitan and South Side companies, which are in independent hands.

OHIO TROLLEY CONSOLIDATION.—The consolidation of various trolley lines in the eastern part of Ohio will result in a continuous line from Erie, Pa., to Youngstown, Ohio, via Sharon, Meadville and Cambridge Springs. The capital of the consolidation will be $2,000,000. George B. Kerper and Henry Burkhold, of Cincinnati, are reported as purchasing for Cincinnati interests the control of the Toledo, Bowling Green & Southern Traction Company. This purchase is for the Cincinnati Street Railway property of the Elkins-Widener syndicate.

LOUISVILLE CONSOLIDATION.—The People's Electric Light Company has been consolidated with the Citizen's General Electric Company. The People's Company was organized with a nominal capital of $25,000. John L. Wells, L. B. Grant, of Brooklyn, and Charles H. Werner, of New York, are stockholders. The Citizens' General Lighting Company will be organized to take over all the gas and electric companies in Louisville with a total capital of $6,000,000.

INTERNATIONAL POWER COMPANY.—President Hoadley, of the International Power Company, states that the $300,000 mortgage on the Corliss Steam Engine Company, held by the Industrial Trust Company, of Providence, R. I., has been paid by the company. The International Power Company owns the following companies: The Corliss Steam Engine Works, Rhode Island Locomotive Works, Providence; the American-Wheelock Engine Works Company, Worcester, Mass., and the Cooke Locomotive Works, Paterson, N. J.

CINCINNATI CAPITALIZATION.—The Cincinnati Gas Light & Coke Company last week increased its capital stock from $9,280,000 to $28,280,000, in accordance with consolidation effected with the Edison lighting interests, and then changed the name to the Cincinnati Gas & Electric Company. The State's fee was $18,000. This step marks the end of a bitter fight between the lighting companies of Cincinnati.

DIVIDENDS.—The Niles-Bement-Pond Company has declared the regular quarterly dividend of 1½ per cent on the preferred stock, payable May 20. The Kings County Electric Light & Power Company, of Brooklyn, N. Y., has declared the regular quarterly dividend of 1½ per cent. The third quarterly dividend of 1 per cent (50 cents per share) has been declared by the American Railways Company, payable June 15.

HAVANA ELECTRIC.—Havana Electric Railway stockholders have ratified the action of directors in voting to increase the capital stock from $10,000,000, of which $5,000,000 is preferred and $5,000,000 common, to $11,000,000, the increase of $1,000,000 to be common stock.

CONNECTICUT RAILWAY & LIGHTING.—J. & W. Seligman & Co. and Redmond, Kerr & Co. have offered at 100 and interest $8,355,000 first and refunding mortgage 4½ per cent gold bonds of the Connecticut Railway & Lighting Company, secured by first mortgage, subject only to $995,000 underlying bonds upon 161 miles of street railway, in 23 cities and towns in southern and western Connecticut, one of the most prosperous districts in the United States, and comprising a population of over 465,000, an increase of 35 per cent in the last 10 years. Among the cities and towns included are Bridgeport, Milford, Stratford, Southport, Shelton, Derby, Ansonia, Westport, Saugatuck, Norwalk, South Norwalk, Darien and Stamford. The company also owns four electric plants supplying New Britain, Southington, Waterbury, Naugatuck, South Norwalk, Norwalk and Greenwich, and controls the gas companies supplying Waterbury and Norwalk. These properties earned, under separate management, $505,335 net, and it is expected that the consolidation will result in a large increase in earnings and a reduction of the cost of operation. The interest charges of the consolidated company are approximately $420,000. A majority of the stock is owned by the United Gas Improvement Company, of Philadelphia, and the management of the company will be under its supervision. A large amount of the bonds have already been sold to investors.

GENERAL ELECTRIC COMPANY ELECTION.—The annual meeting of the stockholders of the General Electric Company was held at Schenectady on May 14. About 60 per cent of the outstanding stock was represented. All the directors were re-elected except Thomas Edison, in whose stead Frederick P. Fish was chosen. The new board of directors is as follows: Gordon Abbott, Oliver Ames, C. A. Coffin, T. Jefferson Coolidge, Jr., Frederick P. Fish, George P. Gardner, Eugene Griffin, Henry L. Higginson, J. Pierpont Morgan, J. P. Ord, Robert Treat Paine, second, George Foster Peabody, Charles Steele.

DETROIT TROLLEYS.—The Detroit United Railway has purchased the Detroit & Northwestern Suburban trolley line between Detroit and Plymouth, 30 miles. The price is said to be $800,000 in 4½ per cent bonds for the stock. It is said to be the purpose of the Detroit United Railway Company to ultimately purchase all the suburban roads running into Detroit, and reorganize as the Detroit United and Surburban Railways.

THE AMERICAN LIGHT & TRACTION COMPANY, which filed articles of incorporation in New Jersey six weeks ago, has filed a certificate showing it had increased its capital stock from $2,000 to $40,000,000. Of the whole 400,000 shares, 250,000 are preferred and the balance common. The incorporators of record are Emerson McMillin, C. F. Scoville and Charles N. King, of Jersey City.

NEW GENERAL ELECTRIC STOCK.—The New York Stock Exchange has listed $2,551,200 additional General Electric common stock.

LIGHTING PLANTS IN NEW YORK STATE.—The Fulton & Oswego Electric Light & Power plants have been sold for $65,000 to Street, Wykes & Co., of New York.

Commercial Intelligence.

THE WEEK IN TRADE.—It is fortunate that the convulsion in the stock market last week had no apparent effect on general trade or the industries. There will not be, in fact, as *Bradstreet's* says, a bushel of wheat or a ton of coal less in the country as a result of the upheaval. General trade advices during the week were in the main rather more favorable than those of the previous week, mainly because of the improvement in crop prospects. The lull in the active buying demand for iron and steel is more pronounced than it was at the time of the last report. This is mainly because mills and furnaces are already heavily sold ahead, and large consumers having placed orders are now waiting delivery. New business is less notable in iron and steel than for some months past, but prices are steady and firm at the quotations of the previous week, with mills and furnaces running to their full capacity. A feature of interest in the trade during the week was the practical completion of arrangements to consolidate the ship building and locomotive building of the country into two great concerns. Gross railway earnings continue to show satisfactory increases. The most significant gain during April being that of 27.8 per cent contributed by the Southwestern lines. The Granger lines show an increase of 2.1 per cent over April last year, thus showing recovery from the effects of the failure of the last spring wheat crop. The total earnings for the month aggregated $49,776,913, against $45,679,174 for April last year, an increase of 8.9 per cent in favor of April this year. The failures for the week as reported by *Bradstreet's*, numbered 193, as compared with 163 the week previous, and 174 the same week last year. In the metal market there is no change recorded as to copper. The leading producers are still holding to their figures of 17 cents for spot and 16⅝ cents for electrolytic. It is stated that large quantities of ore are now coming down the lakes.

SOUTHERN TROLLEY ACTIVITY.—In its issue last week the *Manufacturers' Record* gave a review of electric railroad construction in the South, which shows that part of the country to be the center of remarkable activity. In the State of Kentucky alone it is estimated that nearly 200 miles of trolley lines are planned to be built in the near future, or are actually under construction. But the work is by no means confined to a few portions of the South. In West Virginia a system is being extended around Wheeling. Several important projects are under way in Maryland, including a 25-mile line in the Western section and a line in the Eastern part of the State, to terminate at Wilmington, Del. A company has been organized in Louisiana to build 45 miles in the southern portion of the State. Augusta, Ga., and Aiken, S. C., are to be connected by a 15-mile road, and 30 miles of line will probably be built within the next 12 months in Southern Mississippi. In addition to these projects, the street railway companies in a number of the larger Southern cities will increase their mileage in the near future.

THE ELECTRIC STORAGE BATTERY COMPANY, of Philadelphia, manufacturer of the Chloride Accumulator, has recently closed a contract with the Minneapolis General Electric Company for the enlargement of its present storage battery, which was installed in October, 1899, and the removal of it to a new location. The original installation consisted of 140 elements in lead-lined tanks, and had a capacity at the normal rate of discharge of 4000 ampere-hours. By burning eight additional plates to the bus-bars of each element, this capacity is now brought to a normal discharge rate of 5000 ampere-hours.

THE CINCINNATI MILLING MACHINE COMPANY has been awarded the contract of the British Westinghouse Electric & Manufacturing Company for the entire equipment of plain and universal milling machines and universal cutter and tool grinders. The order consisted of over 60 machines, and was taken in competition with all the prominent builders of this country and Europe. This is the largest order for this class of machines ever placed at one time, and indicates the high opinion held by practical men of the product of the Cincinnati Milling Machine Company.

THE ALLIS-CHALMERS COMPANY, which is to absorb a number of machinery-making plants, reference to which has been made in these columns recently, was incorporated at Trenton, N. J., May 7, with an authorized capital stock of $50,000,000. The incorporators are John F. Charlton, Henry S. Wardner and Stuart Lyman. Of the capital stock, $25,000,000 is to be preferred, bearing a 7 per cent cumulative dividend.

PLANT FOR SOUTH AFRICA.—Mr. Elliott, the retiring manager of the Government railways of the Cape of Good Hope, has been commissioned to choose a system for electrically lighting the railways and to purchase locomotives and cars and material for the construction of the proposed light railways. He will sail for England on May 15 and will make a tour of Europe and the United States in fulfillment of his commission.

THE BULLOCK-WAGNER SALES ORGANIZATION has established a district office at No. 1624 Marquette Building, Chicago. It will be in charge of Mr. H. B. Foster, who has for about two years served the Wagner Company as sales agent. He will have the able assistance of Mr. E. W. Goldschmidt, formerly of the Western Electric Company in covering this most important field.

THE WESTERN ELECTRIC COMPANY, Chicago, is receiving an exceedingly heavy demand for fan motors this season. It is claimed that its total sales thus far for 1901 have by far exceeded those of any previous year. The demand from foreign trade is especially heavy, unusually large orders coming from India and, in fact, throughout the British Possessions.

WEEKLY HALF-HOLIDAY FOR EMPLOYEES.—The General Electric Company has announced that it has decided to give its employees a weekly half holiday with full pay, beginning last Saturday. A petition asking for this has been in circulation for some time.

BOILER CLEANERS.—The Ford Automatic Boiler Cleaner Company, St. Louis, is now equipping two boilers for the Cumberland Electric Light & Power Company, the Maxwell House at Nashville, Tenn.; Morris & Betts' plant at Kansas City, Carleton Building at St. Louis, and several plants in Indianapolis.

THE PITTSBURG REDUCTION COMPANY, Pittsburg, Pa., has ordered from F. R. Dravo & Co., local representatives of the Ball Engine Company, Erie, Pa., a 350-hp engine for direct connection to a generator.

THE AMERICAN BRIDGE COMPANY has received a contract from the Atlantic City Railroad for a 65-ft. turntable at Atlantic City.

EXPORTS OF ELECTRICAL MATERIAL.—The following were the exports of electrical material from the port of New York for the week ended May 2: Antwerp—16 packages electrical material, $645. Argentine Republic—175 cases electrical material, $6,224; 16 packages electrical machinery, $1,632. Aberdeen—27 cases electrical goods, $350. British Possessions in Africa—3 cases electrical material, $255; 1 case motor vehicles, $1,725. British Guiana—23 packages electrical material, $530. Bergen—1 case electrical material, $15. Brazil—245 packages electrical material, $16,807. Bremen—21 packages electrical material, $665. British Australia—2 cases electrical material, $145; 2 packages electrical material, $15. British East Indies—3 cases electrical machinery, $232. British West Indies—45 packages electrical material, $1,265. Birkenhead—159 packages motor trucks, $3,475. Central America—70 cases electrical material, $932. Cuba—218 cases electrical material, $2,177. Chili—4 cases electrical material, $484. Christiania—1 case electrical material, $150. Dutch East Indies—1 case electrical material, $95. Ecuador—15 cases electrical material, $293. Glasgow—31 cases electrical machinery, $5,041; 8 electric launches, $6,400; 38 reels cable, $11,659. Genoa—70 packages electrical material, $5,066. Hull—55 packages electrical machinery, $2,750. Hamburg—6 packages electrical machinery, $5,750; 72 packages electrical material, $3,710; 1 auto vehicle and parts, $200. Hayti—1 case cable machinery, $60. Havre—19 packages electrical material, $911; 236 cases electrical machinery, $30,323. Liban—3 cases electrical machinery, $500. Liverpool—82 packages electrical machinery, $14,224; 93 packages electrical material, $5,029. London—286 packages electrical material, $19,246; 239 packages electrical material, $15,978. Madrid—11 cases electrical machinery, $900. Milan—7 cases electrical material, $280. Marseilles—1 case electrical material, $40. Middlesborough—2 cases electrical material, $139. Mexico—166 packages electrical material, $2,191. Manchester—18 packages motor trucks, $2,400. Nova Scotia—8 cases electrical machinery, $1,125; 2 bags electrical material, $11. New Castle—1 case electrical material, $34; 12 packages electrical machinery, $3,900. New Foundland—5 packages electrical material, $174. Naples—1 case electrical material, $5. Peru—14 packages electrical material, $903. Port Said—2 packages electrical material, $26. Preston—15 packages electrical material, $525. Portsmouth—1 case electrical material, $300. Santo Domingo—28 packages electrical material, $554. Sheffield—1 case electrical material, $111. Stockton—10 cases motor trucks, $1,220. Southampton—15 packages electrical material, $1,230; 1 case electrical machinery, $313. United States of Colombia—30 cases electrical material, $1,218. Venezuela—8 packages electrical material, $161. Vienna—3 cases electrical material, $366. The following were the exports of electrical material from the port of New York for the week ended May 8: Argentine Republic—18 packages of electrical material, $309. Antwerp—1 package electrical material, $37; 19 packages electrical material, $362. British Possessions in Africa—99 packages electrical material, $6,282; 52 packages electrical material, $6,385. British West Indies—40 packages electrical material, $877; 4 cases electrical machinery, $375. Berlin—46 cases electrical material, $3,542; 14 cases electrical machinery, $112. British Guiana—12 packages electrical material, $316. Bremen—7 cases electrical material, $324. Brazil—2 packages electrical material, $26. British Australia—51 packages electrical material, $6,534. British E. T.—12 packages electrical material, $1,105. Central America—77 packages electrical machinery, $1,271. China—6 packages electrical machinery, $270. Cuba—170 cases electrical machinery, $2,787. Glasgow—89 packages electrical machinery, $3,848; 34 packages electrical machinery, $3,080. Genoa—1 case electrical machinery, $10; 8 packages electrical material, $185. Hamburg—1 package electrical machinery, $765; 70 packages electrical material, $2,393. Havre—53 packages electrical material, $3,952; 1 package electrical machinery, $150; 13 packages electrical machinery, $537. Japan—49 cases electrical machinery, $24,134; 67 cases electrical material, $5,352. London—31 packages electrical machinery, $7,783; 16 cases electrical material, $914. Lisbon—11 packages electrical material, $208. Leicester—2 packages electrical material, $50. Liverpool—153 packages electrical material, $5,565; 11 packages electrical material, $618. Marseilles—75 cases electrical machinery, $800. Milan—3 cases electrical material, $100. Mexico—404 cases electrical material, $10,108. Market Harborough—3 cases electrical material, $364. Naples—10 packages electrical material, $65. Philippines—117 packages electrical machinery, $6,780; 1 case electrical material, $30. Preston—2 cases electrical material, $40. Peru—2300 packages electrical material, $17,715. Santander—5 cases electrical material, $151. Suez—1 coil cable, $834. Southampton—64 cases electrical material, $6,944. San Domingo—4 cases electrical material, $35. St. Petersburg—6 packages electrical material, $326. U. S. of Colombia—11 packages electrical material, $45. Venezuela—26 packages electrical material, $405.

POWER IN MONTANA.—A large force is at work on the electric power plant of the Missouri River Power Company, 16 miles from Helena, Mont., putting in a forebay and increasing the electric installation at the dam from four dynamos to ten, preparing for the transmission of the electric power to Butte. The additions to the plant will cost in the neighborhood of a million dollars. The Missouri River Power Company has sold all of its power to the mines at Butte, and there is a demand for an additional 15,000 horse-power at that place. The company is seriously considering the plan of constructing another dam seven miles below the present one. People representing the Missouri River Power Company have secured options on the lands and rights of the company owning the site seven miles below, and are now in New York arranging the details. The power from the new dam will be taken over the same pole lines to Helena and Butte. It is estimated that there are 100,000,000 tons of ore in this deposit that will average $2.50 per ton in gold. This ore cannot be treated except at the Missouri River, because of the lack of water for a mill of sufficient capacity to treat the ore at a profit.

TROLLEY IN CONNECTICUT.—The reported and probable acquisition by the New York, New Haven & Hartford Railroad Company of the Worcester & Webster and Webster & Dudley Street railways, outlines a trolley enterprise of large magnitude. When the system is completed the New Haven Company will control in eastern Connecticut and southern Massachusetts 60 or 70 miles of trolley track, much of it paralleling its Norwich and Worcester division. The company is thus in the unique position of paralleling its own lines by a system of trolleys. But the Norwich and Worcester division is essentially a freight road. As against the sacrifice in part of local passenger traffic, the company seems to have met shrewdly the development of a local trolley traffic in passenger traffic, the supply of light and power in various towns, the prevention of freight competition which was threatened by the trolley enterprise under outside ownership, and, finally, the prospective development of freight traffic by trolley laterals to factory points nearby but not reached directly by the steam road.

POLICE AUTOMOBILES.—Extract from the annual report of Chief of Police Bill of Hartford, Conn., to the Court of Common Council on the operation of a Mark XI. Columbia wagonette by the local Police Department, says: "The electric wagonette which has been used instead of the patrol wagon, drawn by horses, for several weeks, pending the delivery of the new electric patrol wagon, has given satisfaction. It has exceeded my expectations under the most severe tests. It is superior to the conveyance previously used in cleanliness and speed, and can be run more economically. The wagon does the work of four horses at a nominal expense of about 18 cents per day for power. I can safely say that the wagon is admirably adapted for the use to which it is put, and the Department has occasion to feel proud that it is one of the first in this country to be equipped with a vehicle that is modern and ornamental as well as useful."

ELECTRIC CANAL BOATS.—A special dispatch from Cleveland repeats what has become a rather old story, as follows: Cleveland capitalists are financing a company that will propel canalboats by electricity from Toledo to Cincinnati. It will be known as the Miami & Erie Canal Transportation Company. Power will be furnished by small motors. The time of the trip from Toledo to Cincinnati will be lessened two-thirds. The line will cost $6,000,000. Warehouses will be established along the line, and an extensive business carried on. Work on the plan will begin immediately between Cincinnati and Dayton.

ELECTRIC CANAL OPERATION.—The *Journal of Commerce* publishes a London dispatch, saying that Frank W. Hawley, of the Erie Canal Traction Company, has secured Government concessions which place the control of the canals of Holland and Belgium in the hands of his company, which is closely identified with the Morgan interests. The experiments here and abroad were recently illustrated and described in the pages of the ELECTRICAL WORLD AND ENGINEER.

TROLLEY CONTRACT.—The contract for constructing the standard gauge electric railway between Tacoma and Seattle has been awarded to Carl G. M. Miller, of Boston. The money has been furnished by N. W. Harris & Co., New York; Kidder, Peabody & Co. and Stone & Webster, of Boston. Construction has already commenced. Work has also been begun on the extension of the Tacoma trolley lines to Spanaway Lake, 10 miles south, where a summer resort is to be opened.

SPANISH FUEL EXHIBITION.—An exhibition is to be held at Barcelona of apparatus for utilizing fuel, and American exhibits have been granted admission until June 20. They should leave not later than June 1 by Spanish direct steamer, Compania Transatlantica, Ceballos & Co., agents, 80 Wall Street. Mr. Kendall Park, 11 Calle Cristina, Barcelona, will look after American interests. Grates, smoke appliances, automatic stokers, etc., are all included in the exhibition which is intended to develop Spanish coal interests.

BOILER WANTED.—The city of McLeansboro, Ill., is in the market for a tubular boiler, 60 inches in diameter, by 18 ft. long, to have 50 4-inch tubes, capable of hydraulic test of 200 lbs. pressure and 125 lbs. safe working pressure. Mr. B. D. Clover is the engineer.

General News.

THE TELEPHONE.

SAN FRANCISCO, CALIF.—The Christian Co-operative Telephone Association, which operates lines in and around Sunnyside, Wash., has decided to double the capacity of its equipment this season. The Pacific States Telephone & Telegraph Company will soon extend its lines to Sunnyside and compete with the Christians.

EAST ST. LOUIS, ILL.—The Kinloch Telephone Company is increasing the number of its subscribers in Venice, Granite City and Madison, Ill. Fifty new stations have been installed in the past month. Miss Stella Baughan is representing the company, and is probably the only woman in Illinois to whom is intrusted the work of superintending telephone construction. She is in charge of the Madison central office.

STRONGHURST, ILL.—The Henderson County Telephone Company is enjoying an excellent growth. It has recently installed thirteen telephones in Oquawka and a like number in Stronghurst. Business is increasing so rapidly that it will be necessary to construct a number of new country lines. The company expects to put up full copper metallic toll lines in the near future to replace the grounded circuits now in use. The company's lines now cover 200 miles of territory in Henderson and adjoining counties in Illinois. Mr. H. E. Scovern is general manager.

INDIANAPOLIS, IND.—The Charlottsville Rural Telephone Company, of Hancock County, has been incorporated. Capital stock, $2,000.

INDIANAPOLIS, IND.—A chess tournament is being conducted in this city by telephone. There is an "uptown" and "down town" club, each maintaining three tables, presided over by a conductor, who receives and announces the moves made by the respective players.

TERRE HAUTE, IND.—The Retail Merchants' Association decided to use only the telephones of the new local company, and to take out the telephones of the Bell Company, on the ground that "the lowering of rates is directly due to the advent of the Citizens' Company."

ST. LOUIS, MO.—New telephones have been placed in the Board of Education building for the use of the officers of the board. There are eleven of them.

JEFFERSON CITY, MO.—The Stet-Rockingham and Norborne Telephone Company, of Stet, has been granted incorporation papers. The capital stock is $5,000. The incorporators are John B. Early, J. H. Bryan and others.

HENDERSON, N. C.—The Henderson Telephone Company has increased its capital stock to $100,000, and will this coming summer build a number of new exchanges and toll lines. The Carolina & Virginia Telephone Company will build about 200 miles of copper toll line to connect its different exchanges and those of the Henderson Company.

ITHACA, N. Y.—The Century Telephone Construction Company, of Cleveland, which is building a number of exchanges in New York State, has made application for a franchise here.

NEW YORK'S MANY TELEPHONES.—Low rates and energetic pushing for business have done wonders for the New York telephone system. A few years ago there were barely ten thousand telephones in New York. To-day there are over sixty thousand, forming the largest city telephone system in the world. The growth of the telephone list during the last few years has been one of the remarkable features of the general improvement in communication that has marked the past decade. A very short time ago a system of 10,000 subscribers was considered a large exchange even for a city of the first magnitude. Now such a figure seems small, as the net increase in New York during the last year was over 15,000 stations. For the year before that it was 12,500, and for the previous year over 8,000, so that the rate of growth is increasing each year. If this keeps up New York bids fair before long to realize the telephone man's ideal, which is a telephone to every place of business and in every residence in the city. New Yorkers have of late years taken very kindly to the telephone as an adjunct to the comforts of home. A few years ago the telephone was rarely seen except in business places, but now it is rapidly being adopted by residences and by the better class of retail stores.

SEBRING, OHIO.—The Columbiana County Telephone Company has completed its exchange at this point.

CANAL WINCHESTER, OHIO.—The Franklin County Telephone Company has opened its exchange in this place with 55 subscribers.

NAPOLEON, OHIO.—The Henry County Home Telephone Company has been incorporated to operate in this county. Capital stock, $50,000.

SPRINGFIELD, OHIO.—The United States Telephone Company has been given a franchise to operate a toll line and long-distance station in this city.

NEW PHILADELPHIA, OHIO.—The Tuscarawas County Telephone Company has been incorporated to build an exchange in this place. Capital stock, $200,000.

SPENCERVILLE, OHIO.—The Spencerville Telephone Company has been incorporated by A. C. Burr, H. M. Ashton and others to build a local exchange. Capital stock, $20,000.

ALLIANCE, OHIO.—R. Beacon, general manager of the Stark County Telephone Company's exchange, will in the future have charge of the Canton exchange as well as the Alliance.

THE HOME TELEPHONE COMPANY, of Greenville, Ohio, claims to have secured the largest number of contracts this year of any independent concern in the Central West.

PAINESVILLE, OHIO.—The Painesville Telephone Company has purchased a building site and will erect and equip a new exchange building. E. L. House is general manager of the company.

TOLEDO, OHIO.—Construction work on the Toledo & Detroit Shore Line Railway has been started by the Erie Construction Company, which has a subcontract for building forty miles of road.

SALEM, OHIO.—The Columbiana County Telephone Company has closed a deal with the Phœnix Telephone Company, of Toronto, for the purchase of the exchanges at Toronto and New Cumberland. Both exchanges will be remodelled and will be given long-distance service.

CLEVELAND, OHIO.—The Federal Telephone Company is said to have practically completed a deal for the purchase from the National Telephone Company of Ft. Wayne of a dozen independent exchanges on a line between Van Wert and Toledo, including all of the company's properties in Ohio.

NAPOLEON, OHIO.—The Henry County Telephone Company has been incorporated, with $50,000 capital stock, by E. L. Barber, Joseph Brailey, S. M. Heller and F. D. Prentiss. The company will build an exchange at Napoleon, with toll lines through Henry, Fulton, Defiance, Wood and Ottawa counties.

CLEVELAND, OHIO.—The flood in the Ohio River Valley entirely disabled the service of the United States Telephone Company at Uhrichsville, Newcomerston and several other points. It was only within the past few days that the waters have receded sufficiently to commence work of rebuilding the lines.

MADISONVILLE, OHIO.—The Madisonville Telephone Company (Bell) will open its exchange in this place within the next thirty days. Rates will be as follows: Business private line, $2.50 per month; four party line, $2.00 per month; residence, private line, $2.00; six party line, $1.50. Connection will be made with the Cincinnati exchange.

TOLEDO, OHIO.—The Toledo Home Telephone Company, which is known as the Graves Company, and which is supposed to be backed by the Federal Telephone Company of Cleveland, has secured about 2,000 contracts for telephones. This is one of three companies which are working for a franchise in Toledo.

EATON, OHIO.—The two independent companies in Preble County are at war with one another. The difficulty arose through the alleged failure of the Eaton Telephone Company to account to the West Alexandria Company for a share of the business done over its lines. The West Alexandria Company is soliciting subscribers in Eaton and the Eaton Company is returning the compliment by working for business in West Alexandria.

CLEVELAND, OHIO.—H. W. Crumb, of the Pittsburg & Allegheny Telephone Company, was in this city recently perfecting arrangements for the completion of the long-distance line which his company is building in connection with the United States Company between Cleveland and Pittsburg. This line will be completed within the next two weeks and will give connection with 4,000 telephones at Pittsburg and Allegheny besides many exchanges in Pennsylvania.

YOUNGSTOWN, OHIO.—Messrs. A. E. Adams, Jules Voutrout, Jr., of this city; C. B. Shelby, of Warren, and S. B. Claypool, formerly of this city, but now located at Seattle, have secured an option on the properties of the Columbia Telephone Company of Portland, Oregon. The gentlemen mentioned propose to build an exchange at Tacoma and consolidate with the Portland and Seattle companies, which are already built. The consolidated company will have a capital stock of $1,000,000.

CLEVELAND, OHIO.—Judge J. M. Thomas, general manager of the United States Telephone Company, in speaking of the effects of the recent snow and sleet storm upon the lines of the independent companies in Ohio, stated on account of the superior construction used, the lines were not seriously affected. "In fact," said Judge Thomas, "we were able to give first class service on nearly all of our lines every moment of the time. We had to move a few telephones temporarily at two or three exchanges along the Ohio River, but the independent companies suffered no loss worth considering." General Manager Mark Davis, of the Cuyahoga Company, stated that a few lines were temporarily thrown out of service, but the company did not lose a single pole. The Cleveland Telephone Company (Bell) lost a large number of poles in various portions of the city.

CLEVELAND, OHIO.—The Detroit People's Telephone Company, which is owned largely by the Everett syndicate of this city, has completed plans for the erection of an expensive office and exchange building in the business portion of that city. Maxime Reber and James B. Hoge, of the Reserve Construction Company, which will build the exchange, have placed a contract with the Kellogg Company for the switchboard for the exchange which will have an ultimate capacity of 12,000 lines. The promoters of the Detroit Company are also interested in a large exchange being installed at Pontiac, Mich. Both exchanges will be connected with the lines of the United States Telephone Company, which is now building long distance lines covering nearly all the independent exchanges in Southern Michigan.

PORTLAND, OREGON.—The Portland city council is about to take action upon the petition of the Pacific States Telephone & Telegraph Company for an extension of franchise. The petition asks for a franchise granting the company the right to continue to maintain and operate a telephone and telegraph system in the city of Portland for thirty-five years.

PITTSBURG, PA.—The Central District & Printing Telegraph Company has sent notices to a number of the suburban districts notifying its subscribers that in the future it will no longer allow the rebate, which it has been customary to give. This order will affect from 800 to 900 telephones in Greensburg and Sharon, Pa., and it means a difference of about 50 per cent. in the yearly rate.

PITTSBURG, PA.—The corporations committee of councils of Allegheny City approved an ordinance granting the Pittsburg & Allegheny Telephone Company the right to use the city poles for stringing its wires. The ordinance provides that the Telephone Company shall pay a yearly tax of $2 per pole, the city to keep the poles in repair. This tax is additional to the 2 per cent. of the company's gross receipts which has been provided for in the original franchise ordinance.

PITTSBURG, PA.—The Pittsburg & Allegheny Telephone Company is installing a number of automatic toll stations in this city as well as across the river, and the charge for three minutes' conversation will be five cents, which is half the amount charged by the local Bell Telephone Company. The new company has made wonderful headway here, and has now a total of 4800 subscribers on the list, 1600 having been added within the last three months.

PITTSBURG, PA.—In order to make the appearance of the telephone girls as nearly uniform as possible, the Pittsburg & Allegheny Telephone Company recently issued an order for all of its women employees to dress in black skirts and blue waists. Some of them took exception to this rule and they refused to comply with it. But the company sent home all of those who objected, with instructions not to return until they felt disposed to obey. For a few days some of them remained stubborn, but when they realized that the company was determined in the matter they all came around in black and blue.

RICHMOND, VA.—The new long distance telephone system in Virginia is about two-thirds completed. Charlottesville, Harrisonburg, Lexington, Richmond, Staunton, Buchanan, Roanoke, Bedford City and Lynchburg are connected and Petersburg and Newport News will be connected by about July 1. N. C. Watts, general manager and superintendent, says the system is as nearly perfect as modern appliances can make it. Other extensions are contemplated.

ELECTRIC LIGHT AND POWER.

SAN FRANCISCO, CALIF.—The Mountain Copper Company has closed a contract with the Keswick Electric Power Company, H. H. Noble, president, for 1,500 horse-power, to be transmitted to Keswick as soon as the company has completed its new electric transmission plant near Shingletown, Calif.

SAN FRANCISCO, CALIF.—The Bay Counties Power Company recently transmitted electric power from the North Yuba generating station to San Jose, Calif., a distance of about 190 miles. The test was satisfactory, and the company will soon be supplying current over this line to the distributing system of the Standard Electric Company, whose generating plant will not be completed for six months or more.

SAN FRANCISCO, CALIF.—The new Indian School, which is to be established in Riverside, Calif., will have an independent electric light and power system. Proposals will be received until June 5 by the Commissioner of Indian Affairs, Washington, D. C., for twelve brick school buildings and electric light, steam heat and water and sewer systems for the new institution. Further information can be obtained by applying to Harwood Hall, superintendent Indian School, Perris, Calif., or at the office of Indian Affairs, Washington, D. C.

COLUMBUS, GA.—On account of the slipping of a belt resulting in the shattering of the belt wheel at the electric light plant, the town has been thrown into temporary darkness. The accident, it is said, may result in the city's purchasing a modern plant.

ATLANTA, GA.—The Atlanta Railway & Power Company has accepted a franchise for electric lighting offered by the city, and has filed a bond of $40,000 to begin the installation of the plant within sixty days and to complete the system within one year. Ernest Woodruff, the president, states that within ninety days the company will be furnishing power and lights in the central portion of the city.

BLOOMINGTON, IND.—The Bloomington Electric Light Company, recently organized here, has secured a 50-year franchise.

LAFAYETTE, IND.—The Royal Center Electric Light Company, of Royal Center, has been incorporated. Capital stock, $10,000.

ANDERSON, IND.—This city is arranging to erect a new electric light plant, to be paid for on the instalment plan at 5 per cent. interest.

MISHAWAKA, IND.—The Dodge Manufacturing Company is receiving bids with a view of letting the contract for the installation of an extensive electric light plant for its immense establishment.

INDIANAPOLIS, IND.—The Board of Public Works is being strenuously opposed by the people in its efforts to let a new electric light contract. The present contract does not expire for two years.

TERRE HAUTE, IND.—The Root Mercantile & Industrial Company, of this city, contemplates the operation of an independent electric light plant of sufficient capacity for lighting its own buildings and others in the vicinity.

HAMMOND, IND.—The Hammond Illuminating Company has been incorporated, with a capital of $350,000. The company proposes to supply gas and electric light to the city and the citizens. The board of directors is headed by Senator Wm. H. Gostlin.

WABASH, IND.—Frank Clark, chief electrical engineer of the Big Four Railway, is installing electric light plants for the company at this place and at Brightwood. All of the round-houses, offices and station buildings at these and other points are to be lighted by electricity.

LAWRENCEBURG, IND.—Fox & McKim have been awarded the contract for the new municipal plant here, which will be installed on the franchise basis, at an approximate cost of $31,000. The equipment will include a Greenwald engine and a Ft. Wayne 75-kw low frequency alternator. Enclosed arcs will be used.

ALEXANDRIA, IND.—The Lake Erie & Western Railway Company has appealed from a $50 fine imposed by this city for failure to maintain arc lights at the street crossings. This appeal is to test the validity of a city's right to compel a railroad to erect and maintain lights at crossings. If the decision is adverse to the railroads other cities will pass like ordinances.

BRAZIL, IND.—This city is arranging to purchase an electric light plant on the deferred payment plan, and to install it next January, when the contract with the local company expires. The city authorities report an offer from Indianapolis parties to put in a plant to be paid for in annual installments, not to exceed the amounts now paid for light. The city will then bid for domestic service.

BOSTON, MASS.—About 500 electric linemen in Boston and vicinity struck on May 4 for a nine-hour day and $3 pay. The companies affected are the Boston Elevated, New England Telegraph & Telephone, Cambridge Electric Light, Brookline Electric Light, Malden Electric Light, Suburban Gas & Electric Light, Somerville Electric Light, Quincy Electric Light, and the Boston Electric Light.

ST. LOUIS, MO.—The draft of an ordinance for a municipal electric lighting plant to supply light to the public buildings and city institutions has been furnished to the mayor by the president of the board of public improvements.

OSWEGO, N. Y.—The Fulton & Oswego Electric Light & Power plants have been sold for $65,000 to Street, Fykes & Company, of New York City.

ALBANY, N. Y.—The Rome Gas, Electric Light & Power Company, of Rome, has been incorporated. Capital, $400,000. Directors: James T. Lynn, of Detroit; Martin B. Daly, of Toledo, Ohio, and John D. McMahon and others, of Rome.

ALBANY, N. Y.—The Middleport Gas & Electric Light Company, of Middleport, Niagara County, has filed its papers of incorporation with the Secretary of State. It has a capitalization of $50,000 and its directors are W. C. Johnson and F. A. Dudley, both of this city, and L. E. Sterritt, of Middleport.

LONDON, OHIO, has purchased a Babcock & Wilcox water tube boiler of about 300-hp; also a 175-hp Russell four valve engine and a 100-kw Ft. Wayne alternator with new switchboard and auxiliary apparatus, an increase of its present lighting plant.

CINCINNATI, OHIO.—The new board of directors of the Cincinnati Gas & Electric Company, with $28,000,000 capital, organized on May 8. Andrew Hickenlooper, of the old gas company, was elected president, and C. W. Wetmore, vice-president, in charge of the electrical department.

OTTAWA, ONT.—Mr. Louis Simpson, formerly manager of the Montreal Cotton Mills, has secured concessions at a place known as Chats Falls, some twenty miles above Ottawa, where, he says, he has 100,000 horse-power at his command. Mr. Simpson states that industries of equal magnitude to those of Sault Ste. Marie will be established at the falls in the near future. Outside capital is behind the enterprise.

NORFOLK, VA.—At the annual meeting of the Norfolk Heat, Light & Power Company, Geo. M. Bunting, of Chester, Pa., was chosen president. The company's new power-house will soon be completed.

THE ELECTRIC RAILWAY.

SAN FRANCISCO, CALIF.—The London & San Francisco Bank recently purchased at execution sale all of the property of the Salem Light & Traction Company, of Salem, Oregon. This action was taken in pursuance of the foreclosure of a mortgage held by the bank. The property was bought in at the amount of the judgment, including accrued costs, $144,013. There will be no immediate changes in the local management.

SAN FRANCISCO, CALIF.—It is reported that a new company, organized for capitalists representing the Fair and Crocker estates, has completed plans for constructing a standard gauge electric railroad from Bully Hill, Calif., to the Sacramento River, a distance of twelve miles. It is said that there will be no stock placed on the market, as the company is assured freight contracts from mining companies that will make the line very profitable. Rights of way have been secured for building the road from a connection with the Southern Pacific near Kennett to the De la Mar mine at Bully Hill. The Shasta Electric Light & Power Company has contracted to supply the electric power by Nov. 10.

COLORADO SPRINGS, COL.—Colorado Springs, Denver and Pueblo will be joined by a trolley line to cost $2,500,000. It will be built by Chicago, Detroit and Cleveland capitalists.

NEW HAVEN, CONN.—It is stated that an arrangement has been made, allowing the Middletown Street Railroad Company to extend its system several miles to Highland, on the Waterbury, Meriden and Cromwell steam railroad.

WILMINGTON, DEL.—The City Railway Company has awarded to Patrick Fahey the contract to build a new power house along the Brandywine, the cost being $150,000.

DOVER, DEL.—The Delaware General Electric Railway Company filed with the Recorder of Deeds for Kent county, Del., a mortgage of $1,000,000 to the Knickerbocker Trust Company, of New York, for the construction of the Kent county trolley.

ATLANTA, GA.—The Atlanta Railway & Power Company has re-elected all of the old officers. Mr. E. Woodruff is president.

SHIRLEY, IND.—A company headed by A. J. Miller is projecting an electric railway to connect this city with Muncie and Greenfield.

INDIANAPOLIS, IND.—The Washington and Loogootee Railway Company has been incorporated, with a capital stock of $20,000.

MUNCIE, IND.—F. G. Brownell has sold his proposed electric road from Muncie to Hartford City to Messrs. Baxter and Schoner, of Cleveland, Ohio.

RICHMOND, IND.—The Richmond Street & Suburban Railway Company, capital $500,000, has filed articles of incorporation. Henry B. Smith, of Hartford City, is president, and Charles Murdock, of Lafayette, secretary.

RICHMOND, IND.—The Richmond Street Railway plant has been transferred to James Murdock and associates of Lafayette, who have for the past year contemplated the building of an electric line from Richmond to Combridge City, and from that point to Greenfield.

EVANSVILLE, IND.—The Evansville Street Car Company, which has been in the hands of a receiver for two years, has been sold at public sale for $100,000 to John Elliott Bolles, of New York City, representing old bondholders. The company had recently obtained a fifty-year franchise.

CHICAGO, ILL.—It is stated that the Chicago City Railway Company proposes to place its electric feeder cables underground in the paved streets along its main line.

BALTIMORE, MD.—The Baltimore & Washington Electric Railway Company, which intends to build a trolley road from here to Washington, with a branch to Annapolis, organized here on May 7 and acquired the charter for the road to Annapolis, having already secured the franchises between Baltimore and Washington. It is understood that the capital stock will be $1,500,000, and that there will also be a bond issue.

AUGUSTA, ME.—The railroad commissioners have approved articles of association of the Saco Valley Electric Railway Company, whose road will run from Saco to Buxton and thence to Standish, a distance of twenty miles. The company is capitalized at $250,000.

BOSTON, MASS.—The railroad commission has dismissed the petition of the Palmer & Monson Street Railway for issue of $195,000 mortgage bonds, as in the opinion of the board the value of the road does not equal the amount of capital stock and debt.

CITY OF MEXICO, MEX.—It is proposed to extend the electric street railway line, which now connects Villa Lerde and Gomez Palacio, to Torreon, in the State of Durango, Mexico.

CITY OF MEXICO, MEX.—The board of directors of the company owning and operating the street railways in the City of Mexico, at their annual meeting decided best, as a matter of business convenience, to separate the original corporation into two companies or divisions to be known as the Mexico Electric Tramways, Limited, and the Compania de los Ferrocarriles del Distrite. The latter organization really represents the interest of the old holders of the 6 per cent. purchase bonds. The following board was elected of the Mexico Electric Tramways, Limited: President, Hon. Chandos S. Stanhope; vice-president, Joaquin D. Casasus; vocales, Captain Perfirio Diaz, Jr., A. E. Worswick and Charles Clegg.

HOBOKEN, N. J.—The Bergen Turnpike Company contemplates constructing a trolley line from Hoboken to Hackensack.

TRENTON, N. J.—The syndicate headed by Tom and Albert L. Johnson has purchased the Trenton, Morrisville and Yardley trolley line, which runs from Morrisville to Yardley on the Pennsylvania side of the Delaware River.

ALBANY, N. Y.—The West Chester Electric Railroad Company proposes to extend its road from its present terminus in New Rochelle.

NEW YORK, N. Y.—The stockholders of the Havana Electric Railway Company have voted to increase the common stock from $1,000,000 to $11,000,000.

SANDY HILL, N. Y.—The Greenwich & Schuylerville electric road has made a connection to-day with Glens Falls, Sandy Hill and Fort Edward, at the latter place.

CORTLAND, N. Y.—C. D. Simpson, of New York, bought at a foreclosure sale for $50,000 the Cortland & Homer Traction Company and the Cortland & Homer Electric Company.

NEW YORK, N. Y.—W. B. Strong, Jr., of 15 Wall Street, has closed a contract with the Everett-Moore syndicate of Cleveland, Ohio, for the building of the Detroit & Toledo Shore Line, which will be constructed as a trolley line.

ALBANY, N. Y.—The Troy, Rensselaer & Pittsfield Railroad Company has been incorporated. Capital stock, $350,000. The route covered is through Troy and the towns of Brunswick and North Greenbush, Rennselaer County, City of Rennselaer, Town of Nassau and Town of New Lebanon, Columbia County.

CORTLAND, N. Y.—The franchises and property of the Cortland & Homer Traction Company were recently sold at a mortgage foreclosure sale. The mortgages were held by the Farmers' Loan & Trust Company of New York. Only one bid, $50,000, was made by C. Simpson, of New York, who is understood to represent the bondholders.

NEW YORK, N. Y.—The cable service of the Lexington Avenue division of the Metropolitan Street Railway system has been finally abolished in favor of the electric conduit system. For the present passengers are required to change cars at Twenty-third Street and Broadway until the Broadway line has been changed over to the electric system.

NEW YORK, N. Y.—The Rapid Transit Commissioners have voted to adopt a plan which will provide for the construction of a three-track road above 103d Street on the West Side branch. The plans will have to be approved by the Municipal Assembly before they can be carried out. It was also decided to have a station for the road under City Hall Park.

LYONS, N. Y.—The Lux Electric Railroad combination, which proposes to connect Rochester and Syracuse by an electric road, has incorporated the Macedon Electric Railroad Company, capitalized at $30,000. The combination now has similar companies in Clyde, Lyons, Newark and Palmyra. The directors of the Macedon Company are Charles A. Lux, Albert C. Lux, Daniel E. Lux, Charles F. Lux, Thomas Robinson, Charles A. Rooker, Samuel P. Nichols, Elliott B. Norris and Nicholas A. Mestler.

NEW YORK, N. Y.—The Metropolitan Street Railway Company has rearranged its transfer system in this city. The readjustment was made in anticipation of the changing over of the last cable line to electric traction, which will be completed about June 1. The change will so increase the facilities of travel as to make unnecessary the separate transfer points now in existence at points where cable and electric cars meet, as though traffic can then be established. The new transfer system is much simpler than the old.

THE BUFFALO, EAST OTTO AND CATTARAUGUS RAILWAY COMPANY has been incorporated, with a capital stock of $800,000, to construct and operate an electric railroad line from Cattaraugus, Cattaragus County, to Hamburg, Erie County, or to Buffalo, a distance of thirty-five miles. The directors are: N. L. Upson, of Orchard Park; L. F. Boies and W. J. Hayes, of Buffalo; H. L. Moench, W. A. Oakes and S. F. Burger, of Cattaraugus; J. O. Hammel and C. H. Mason, of East Otto, and T. P. Truby, of Otto.

ALBANY, N. Y.—The employees of the United Traction Company, of this city, went on a strike on May 7. The cause of the strike is said to be the refusal of the company to accede to certain demands made by the employees. On May 8 the employes at Troy joined the ranks of the strikers, making a total of 1,000 men out. The street railway service in Albany, Troy, Rensselaer, Watervliet and Cohoes was completely suspended. Up to Tuesday morning quiet prevailed, but when the company attempted to run cars with non-union men on Tuesday morning a riotous demonstration ensued. The police were unable to cope with the situation, so part of the militia was called out. As we go to press troops were already in Albany at the scene of disorder.

ROCHESTER, N. Y.—The Rochester & Southern Traction Company has been incorporated, with a capital of $1,000,000. Among the incorporators are: Dr. J. Arthur Jackson, Dr. James E. Crisfield, William Kramer, Frank J. McNeil, and B. H. Oberdorf of Dansville; William H. Gray, Groveland; James B. Frazer, West Sparta; H. E. Gore, John F. Donovan, and John F. Connor, Mount Morris; E. W. Horton and E. F. Youngs, Geneseo; J. M. E. O'Grady, Charles Van Voorhis, Norman Van Voorhis, Willian C. Gray, A. J. Grant and I. M. Ludington, Rochester, and Frederick St. John, of New York.

AKRON, OHIO.—The Northern Ohio Traction Company has voluntarily increased the wages of motor men and conductors on city lines.

COLUMBUS, OHIO.—The Columbus, Delaware & Northern Railroad Company has increased its capital stock from $10,000 to $1,000,000.

DEFIANCE, OHIO.—The Defiance County commissioners have granted a franchise to the Northern Ohio Electric Railway for its road to Bryan.

NILES, OHIO.—The Niles Manufacturing Company will shortly be incorporated with a capital stock of $200,000 to manufacture street cars.

MARYSVILLE, OHIO.—Thomas N. Kerr, treasurer of the Union Electric Railway Company, has secured a 25-year franchise for his road through this city.

CINCINNATI, OHIO.—The Central Traction Company has been organized at Indianapolis, Ind., to build an electric line between Indianapolis and Richmond.

CINCINNATI, OHIO.—The Cincinnati Traction Company will make extensive improvements in the power house at the Bellevue Incline. New engines and machinery are to be put in.

YOUNGSTOWN, OHIO.—Park & Hamilton, the local contractors, will build the Sharon & New Castle Electric Railway. Contracts for the equipment are to be closed in the near future.

CINCINNATI, OHIO.—The Cincinnati Traction Company has placed a contract for twenty-one miles of the Trilby slot rail amounting to $147,000. The contract will aggregate about $175,000.

YOUNGSTOWN, OHIO.—Messrs. John Stambaugh, Jr., S. D. L. Jackson and other wealthy cietizens of this place are organizing a company with $500,000 capital stock to build a line to Steelton.

LORAIN, OHIO.—The Lorain County commissioners have granted a twenty-five-year franchise to the Sandusky & Interurban Railway Company, which will enable it to complete its line into Lorain.

TIFFIN, OHIO.—The commissioners of Seneca and Crawford Counties have granted franchises for two lines connecting Tiffin with Bucyrus. One road is promoted by Gen. E. B. Findley, of Bucyrus.

MANSFIELD, OHIO.—The Richland County commissioners have granted a 25-year franchise to L. M. Coe and F. D. Carpenter, of Cleveland, for the construction of a line between Mansfield and Crestline.

CLEVELAND, OHIO.—The Cleveland, Painesville & Ashtabula Railroad Company has increased its capital stock from $1,000 to $1,000,000. This company is to build the extension of the Cleveland, Painesville & Eastern Railway.

CLEVELAND, OHIO.—The Osborn Engineering Company will shortly call for the equipment of the power house of the Cleveland & Southern Railway Company, which is building a road from Berea to Medina and Wooster.

CLEVELAND, OHIO.—The Pomeroy syndicate, which owns the Cleveland, Elyria & Western Railway and other roads, has secured an option on the Tuscarawas Electric Railway operating between New Philadelphia and Canal Dover.

SPRINGFIELD, OHIO.—In return for the disruption of their union by the street railway motormen, the Springfield Street Railway Company has voluntarily granted an increase of from 1 to 2½ cents an hour, taking effect May 1.

COLUMBUS, OHIO.—The Defiance, Ottawa, Kenton & Columbus Interurban Railway Company has been incorporated by Daniel J. Ryan, George H. Jones, Charles Kinney, Nelson E. Mathews, John M. Sheets and H. A. Fisher. The capital stock is $50,000.

DELAWARE, OHIO.—The Columbus, Delaware & Northern Traction Company, of which James Loren, of Columbus, is president, has completed the purchase of the property of the Delaware Street Railway Company, giving it a right of way through the city.

CLEVELAND, OHIO.—H. T. Clark and J. P. Barthoff, of Cleveland, have secured a fifty-year franchise at St. Joseph, Mich., for a new company, to be known as the Chicago, St. Joseph & Southwestern Michigan Railway. Much of the right of way has been secured.

STRASBURG, OHIO.—There is an opening for capital investment in this place in the form of a street car line. The Strasburg Electric Company was recently incorporated here for the purpose of conducting a business of electric lighting. Mr. Thomas Kemp is president.

TIFFIN, OHIO.—The Toledo, Tiffin & Sandusky Railway Company, which was organized about two years ago, is now being backed by S. B. McKinnon, of Chicago, representing a large syndicate of capitalists, and it is stated that construction work on the line will start at once.

YOUNGSTOWN, OHIO.—The consolidation of trolley lines now in operation or in process of construction has been decided upon. This will give a continuous line from this city to Erie, Penn. The new company will be incorporated under the laws of New Jersey, with a capital of $2,000,000.

CINCINNATI, OHIO.—The Cincinnati & Cleveland Railway Company has amended its charter to enable it to build several branch lines. Officers of the company have been chosen as follows: Powell Crosley, president; Wm. F. Hart, secretary, and the above, with Emert G. Simon, Oliver E. Conner, D. H Hunt, W. Crosley and E. E. Williamson, directors.

CINCINNATI, OHIO.—The Scioto Traction Company is constructing an electric road from Columbus to Circleville and expects to have cars in operation by early winter. It is building on private rights of way. The company has placed

an order for 8,800 tons of steel rails with the United States Steel Corporation. The steel is for tracks from Columbus to Chillicothe and Lancaster.

FREMONT, OHIO.—A contract for the construction of the roadbed of the Lakeside, Napoleon & Western Railway has been placed with H. D. Blodgett, of this place. It is stated that a contract has been placed with the Westinghouse Electric & Manufacturing Company for the equipment of the power house which will be located at Fremont. Construction work on the road will start at once.

AKRON, OHIO.—The Canton, Massillon & Akron Railway Company has been incorporated by E. W. Moore, Barney Mahler, F. A. Henry, J. R. Nutt, Will Christy, A. M. Snyder and L. E. Beilstein. The temporary capital stock is $1,000, which will be increased to $1,000,000. The company will build the extension of the Northern Ohio Traction Company from Akron to Massillon and Canton.

CLEVELAND, OHIO.—The Osborn Engineering Company, Cleveland, is preparing plans for the power house and construction of the Kansas City & St. Joseph Electric Railway Company, which is preparing to build a fifty-mile road in Missouri. Bids for the equipment of the power house will be called for in the near future. Perry N. Gibson, of Erie, Pa., is president of the company.

CINCINNATI, OHIO.—The Cincinnati & Eastern Electric Railway Company has organized with the following officers: George H. Strugham, president and general manager; Lee H. Brooks, vice-president; J. N. Kennedy, secretary and treasurer; William E. Hutton, assistant secretary and treasurer; E. G. Inkhead, general counsel. The company will build a 30-mile line extending east from Cincinnati.

CLEVELAND, OHIO.—The syndicate headed by M. J. Mandelbaum & Company, of this city, which is securing control of properties in the vicinity of Chicago, has purchased another road, the Aurora, Yorkville & Morris Railroad Company, which is projecting a line running twelve miles southwesterly from Aurora. The syndicate will build a gap of three miles at Geneva, Ill., giving through service from Elgin to Aurora and Chicago.

STEUBENVILLE, OHIO.—The new management of the Steubenville Traction Company will spend $500,000 in improving the system. The road is to be extended to Toronto. The two power plants owned by the company are to be remodeled and contracts have been placed for two 100-kw generators, two engines and boilers of 900-hp. A new storage battery plant will be located between Alikanna and Toronto and a large car barn will be built near Alikanna.

DAYTON, OHIO.—The Ft. Wayne, Dayton & Cincinnati Traction Company, which has been incorporated in Ohio and South Dakota, with $1,000,000 capital, has elected officers as follows: Dr. S. F. George, Dayton, president; D. W. LaFreta, New York, first vice-president; Charles L. Hyde, Pierre, S. D., second vice-president; C. W. Gebhart, secretary; C. E. Lucius, treasurer; A. J. Miller, general superintendent; W. H. Pulse, general superintendent, and Ira Hodgson, engineer, all of Dayton.

CLEVELAND, OHIO.—Since January the Everett-Moore-Mahler syndicate has purchased 56,000 tons of steel rails to be used in building projected lines. Of this amount $20,000 tons were placed last week with the Carnegie Company in anticipation of the advance of $2 per ton recently announced. Eight thousand tons will be used in the construction of the Detroit-Toledo Shore line, 8,800 tons for the Scioto Valley Traction Company running south from Columbus, and 2,300 tons for the extension of the Cleveland, Painesville & Eastern Railway. It is stated that the syndicate is projecting nearly 600 miles of road.

FINDLAY, OHIO.—A meeting of the directors of the Findlay & Southern Electric Railway Company was held here recently. The promoters are R. Rosenstock, of Cleveland; M. D. Hammond, Mt. Blanchard; Dr. Jefferson Odenbaugh, Sandusky, and T. I. McConico, of Findlay. The capital stock was increased from $10,000 to $2,500,000, and arrangements were effected with I. W. Newcomer, representing Barney & Company, Philadelphia bankers, for the floating of $2,500,000 in bonds. The road will extend from Findlay to Kenton and Delaware, and eventually will be extended to McComb, Deshler and Toledo. R. Rosenstock & Company, of Cleveland, are the engineers, and construction work will start in the near future.

CLEVELAND, OHIO.—The Little Miami Traction Company which was promoted by John Martin, of Xenia, to build a road from Springfield to Xenia, and later to Lebanon and Cincinnati, has completed arrangements for financing in this city. The company will incorporate with an authorized capital stock of $500,000 and $500,000 bonds, of which $400,000 will be issued at once. The bonds and stock have been underwritten by a syndicate composed of M. J. Mandelbaum & Company, F. T. Pomeroy, W. H. Lamprecht and E. W. Christy, of Cleveland; J. R. Nutt and Will Christy, of Akron, and W. E. Hutton & Company, Cincinnati. The officers of the company are: John T. Martin, president; F. T. Pomeroy, vice-president; H. C. Lang, secretary; J. R. Nutt, treasurer. The Cleveland Construction Company will build the road under the direct supervision of Will Christy.

OKLAHOMA CITY, OKLA.—The Oklahoma Street Railway, Light, Power & Improvement Company has been organized here with a capital stock of $100,000. Following are the officers: Charles F. Colord, president; C. E. Bennett, vice-president; Charles F. Gilpin, secretary and treasurer.

PITTSBURG, PA.—The Pennsylvania Railroad Company has broken ground on the power house, which is to be erected in connection with the new Union Station building the company is now constructing in this city. The structure will cost $110,000.

PITTSBURG, PA.—The board of directors of the Consolidated Traction Company has elected Mr. Joshua Rhodes, president of the company, to succeed Mr. C. L. Magee, who recently died, and Mr. W. Kesley Schoepf was elected vice-president and general manager.

WILKESBARRE, PA.—The Wilkesbarre & Hazleton Railroad Company, composed of the leading spirits of the Lehigh Traction Company, owning electric lines in Hazleton and vicinity, purposes building a traction line between Hazleton and Wilkesbarre. It is to be about twenty-five miles long, or one-half of the distance covered by the steam roads. Work has already begun. The line will connect Scranton and Hazleton and cover the entire Wyoming Valley coal fields.

MONTREAL, QUEBEC.—At a meeting of the Demerara (West Indies) Electric Company, held in this city on April 24, the reports read showed that the road had been so liberally patronized during the last two months, that it was decided to send down more cars to meet the requirements of the rapidly growing traffic. The electric light business is also increasing very fast, and another large generator has been installed.

PROVIDENCE, R. I.—The franchise of the Columbia Street Railway Company for a line from Pascoag, in the town of Burrillville, was transferred to the Woonsocket Street Railway Company.

LYNCHBURG, VA.—Lynchburg's street car lines, gas works, and electric light plants have been purchased by Philadelphia and Lynchburg capitalists and consolidated. The Lynchburg & Rivermont Street Railway Company and the Lynchburg Electric Railway & Light Company will now be merged into the Lynchburg Traction & Light Company, with Richard D. Apperson president and general manager and R. Colston Blackford secretary and treasurer.

BELOIT, WIS.—The Beloit, Delavan Lake and Janesville Electric Railway Company has been granted a 30-year franchise.

MERRILL, WIS.—An electric interurban railway will be built between this city and Wausau, a distance of eighteen miles. Power will be generated at Merrill from water power to be developed.

MILWAUKEE, WIS.—The Milwaukee Electric Company's new plant will be located at West Allis and $40,000 will be expended at present. The entire plant will be most modern in every respect.

MILWAUKEE, WIS.—The common council has under consideration the granting of a franchise for an elevated track system which the Milwaukee, Burlington & Lake Geneva Electric Railway Company wishes to build as its Milwaukee terminal.

SHEBOYGAN, WIS.—The interurban electric railway, which is planned to run from here to Elkhart Lake, will be one of the finest roads in the State, and will carry both passengers and freight. The power-house will be located at Sheboygan Falls. It is estimated that the line will cost about $350,000.

APPLETON, WIS.—The property of the Green Bay & Mississippi Canal Company has been transferred to the Wisconsin Traction, Light, Heat & Power Company. This property will be used for the development of vast improvements of the company's present system and to extend the system of interurban railroads.

EDUCATIONAL.

UNIVERSITY OF MAINE.—The University of Maine in its catalogue this year gives illustrations of the various buildings and a map showing the University campus, location of the buildings, etc.

ROSE POLYTECHNIC INSTITUTE.—The nineteenth catalogue of the Rose Polytechnic Institute, Terra Haute, Ind., contains the calendar for 1901-1902, with an outline of the courses of study and the plan of instruction.

NORTHWESTERN UNIVERSITY.—It is announced that the Northwestern University, at Evanston, Ill., will next year establish a department of electrical and mechanical engineering. The plans are to have the courses equal to the first two years of work at the Massachusetts Institute of Technology. The work will be under the direction of Professor Henry Crew, the present head of the physics department. The services of Dr. Baskin, who is at present doing fellowship work at the University, and F. H. Starkweather, of Boston, have been secured.

SYRACUSE UNIVERSITY.—A new college is opened this year—the College of Applied Science. It comprises courses in civil engineering, electrical engineering and mechanical engineering, the last of which is now offered for the first time at Syracuse University. All this is made possible by the generosity of one of the most enterprising citizens of Syracuse, Mr. Lyman Cornelius Smith, the well known typewriter manufacturer. A fine building is now being erected on the campus to accommodate the department of mechanical engineering. It is 133 by 56 feet, with five floors and a basement, and a drafting room in the lantern roof. Rooms are provided for testing machines, shops, laboratories, lecture and reception rooms, departmental library, museum, etc. The building and apparatus represent the latest and best thought in engineering instruction. Among the courses offered in mechanical engineering are principles of mechanism, carpentry, wood turning, and pattern making, forging, filing, etc., machine tool work, steam engine and thermodynamics, machine design, metallurgy of iron, etc., etc. Twenty-two courses are given in civil engineering, and ten in electrical engineering.

OBITUARY.

E. S. DE MITKIEWICZ.—The death took place on May 14 at Asbury Park of "Count" E. S. de Mitkiewicz, a Polish adventurer, who had a romantic career in this country, and was involved in many financial escapades. One of these related to the introduction of the telephone into China, and became an international sensation. The Chinese did not get the telephone.

PERSONAL.

MR. F. P. FISH, although soon to take up his new duties as president of Bell Telephone, has just been elected a director in the General Electric Company.

MR. J. BAILEY, of Scranton, succeeds Mr. I. T. Lerch as general superintendent of the Pennsylvania Telephone Company, with headquarters at Reading, Pa.

MR. W. E. MANDELICK, for many years connected with Sprague Electric interests, is going to England to become associated with the Yerkes underground railway enterprises in London.

MR. THOMAS V. HALL, C. E., has been appointed by the board of aldermen of West Point, Miss., as engineer to design and supervise the construction of a $15,000 electric lighting plant. Contracts will be let about June 15.

MR. E. H. JOHNSON, who for some time past has been prevented by illness from attending to business matters while in this country, is now in much better health, we are glad to note, and has returned to England to look after matters there.

MR. R. L. AMES has opened an office for the practice of patent law at 1462 Monadnock Building, Chicago. Mr. Ames was for six years an examiner in the electrical department of the patent office, and has recently practiced law in New York City.

MR. W. H. HOLMES, president of the Metropolitan Street Railway Company, of Kansas City, was "constructively confined" in the local jail for ten days recently, for contempt of court, in not submitting the company's books and vouchers to the Grand Jury.

MR. T. S. McLOUGHLIN, 824 Union Street, New Orleans, is the electrical engineer engaged upon the electrical work for a big new seven-story office building at Beaumont, Texas, the new oil centre. He has also contracted for the complete electrical equipment of the new theatre.

MR. ERNEST KILBURN SCOTT, M. I. E. E., etc., has taken offices at Clun House, Surrey Street, London, W. C., as English manager and engineer for the International Electric Company of Liege, Belgium, which has already a number of plants in operation in the British Isles.

MR. R. F. HAYWARD, electrical engineer of the Utah Light & Power Company, of Salt Lake City, passed through New York last week on his way home to England for a brief vacation. He speaks of power conditions as very hopeful. The utilization of electric power by the mines is now universal.

MR. OLIN SAFFORD BLAKESLEE, mechanician and electrician, who by his numerous inventions and calorimeter appliances has been of great service to Wesleyan University, Middletown, Conn., will sever his connection with the institution at the end of the college year, and remove to the West.

MR. ARTHUR VAUGHAN ABBOTT, Chief Engineer of the Chicago Telephone Company, gave an address on high-frequency electrical oscillations with experimental illustrations before the Western Society of Engineers at Chicago May 8, 1901. Mr. Abbott has done considerable research along these lines.

MR. JOHN I. SABIN took up his duties as president of the Chicago & Central Union Telephone Companies on May 10. Mr. W. A. Jackson, his predecessor in the Central Union, will be connected officially with the American Telephone & Telegraph Company. The former president of the Chicago Telephone Company, John M. Clark, has been elected chairman of the board of directors.

HON. C. A. SCHIEREN has an interesting article in the *Saturday Evening Post* telling "Why Young Men Should Begin at the Bottom." In the course of it he describes how some years ago when dynamos first came in, he devised his well known "electric" belting by punching the belt full of holes so as to relieve the air cushion. The article is full of valuable and helpful suggestions to young men.

JOHNSON-STOCKLY.—The marriage is announced to take place on May 23 at noon at the Presbyterian Church, Lakewood, N. J., of Mary Galt Stockly, daughter of Mr. and Mrs. G. W. Stockly, to Mr. Owen McMahon Johnson, son of Mr. R. N. Johnson, the well known editor of the *Century*. Young Mr. Johnson has just made a notable success with his first novel, "Arrows of the Almighty." Mr. Stockly, it will be remembered, was at one time president of the Brush Electric Company.

MR. CHAS. L. ACKERMAN, one of the earliest employees of the old Edison Electric Light Company and the Edison Company for isolated lighting, and now a resident of San Francisco, is in destitute circumstances and affected with incurable locomotor ataxia. Several of his friends have joined together and are proposing to raise a fund to instal him as a life inmate of a home for incurables, providing meantime for his immediate wants. It is desired to raise between $1,000 and $1,500, and Mr. Samuel Insull, president of the Chicago Edison Company, has consented to act as treasurer for the fund. Contributions are now being made, and we desire to commend this good object to the assistance of our charitable readers, who should send their checks to Mr. Insull.

MR. T. P. GAYLORD.—An illustrated lecture on "Alternating Current Power Work," in the series arranged by the Mechanical Engineering and Electrical Engineering Society of the University of Illinois, was delivered April 30 by Mr. T. P. Gaylord, of the Westinghouse Company. The treatment of the subject was thoroughly interesting. Electric generators, oil-cooled transformers, rotary converters and constant and variable speed induction motors of the Tesla type were shown and described. The most recent type of motor shown has been largely and successfully introduced by this company for cranes and hoists, woodworking shops and foundries, and many other industries requiring variable speed. Excellent views and descriptions were given of the large shops of the company at Pittsburg.

MR. HERBERT A. WAGNER, the well known electrical engineer, who has done considerable work in electric lighting development in St. Louis, is opening a New York office as consulting engineer in the *Times* building, New York City. For some time past, owing to the calls upon him for expert advice, Mr. Wagner has had to visit this part of the country frequently. He has of late been engaged by the Edison Electric Illuminating Company of Boston and the Boston Electric Light Company to give assistance on the plans and direction of their proposed extension, as noted in the comprehensive article in this issue. As an inventor Mr. Wagner has also made his mark, and he is a very welcome addition to professional circles in New York City.

MR. I. T. LERCH, who has been general superintendent of the Pennsylvania Telephone Company, with headquarters in Reading since 1891, and previously division superintendent for three years, has tendered his resignation. Mr. Lerch's principal duties with the Pennsylvania Telephone Company were the construction of new lines and maintenance of the system, which covers the eastern part of Pennsylvania and portions of New Jersey. He first engaged in the telephone business at Bethlehem in 1880 as night operator and inspector. The business was then extended from Easton to Hazleton. Later the company sold out to the Pennsylvania Telephone Company, and Mr. Lerch was made manager of the Lehigh district, with headquarters at Easton. He went to Reading in the fall of 1888. Under his administration many improvements were made in the service, and perhaps the most important was the placing of the wires underground there and at other points. In 1888 there were 520 telephones in Reading. To-day there are 2,000. Mr. Lerch will now identify himself with the People's Electric Light Company, which recently secured a franchise from the city. He has purchased the Reading Electrical Construction Company, from J. K. Righter, who runs the business under a limited partnership at present. This firm will be discontinued and a charter applied for to conduct the business under a corporation. It will be enlarged into a supply and construction house.

Trade Notes.

INTERNATIONAL SPECIALTY COMPANY has opened a Chicago office at 1005 Monadnock Block.

THE BROWN ENGINE COMPANY, incorporated at Milwaukee, Wis., to build Corliss engines, will be located at Western Union Junction.

WESTON INSTRUMENTS.—The Weston Electrical Instrument Company has changed its Newark address to Waverly Park, Essex County, N. J.

EXHAUST HEADS.—The Burt Manufacturing Company, of Akron, Ohio, has just entered an order for Burt exhaust heads from the British Government.

THE BARTH MANUFACTURING COMPANY'S plant at Milwaukee, Wis., has been destroyed by fire. The company built electric elevators and was building its own motors.

THE EXETER MACHINE WORKS, Pittston, Pa., in a recently issued catalogue illustrates the Exeter noiseless gravity bucket, conveyors, coal crushers, belt conveyors, etc.

ELECTION OF OFFICERS.—At a recent annual meeting of the stockholders of the Joseph Dixon Crucible Company, Jersey City, N. J., the old board of directors and the present officers were re-elected.

THE VARIETY IRON WORKS, of Cleveland, Ohio, are preparing to erect a new power plant and have placed a contract for a 300-hp Buckeye engine. It is understood that boilers and generators have not yet been contracted for.

THE STANLEY ELECTRIC MANUFACTURING COMPANY, of Pittsfield, Mass., has established a branch sales office at 26 South Fifteenth Street, Philadelphia. Mr. James E. Cutler, late of the New York office, has been appointed district manager.

STOCK REPORT.—The Emerson Electric Manufacturing Company has issued from its New York office, at 136 Liberty Street, its Stock Report No. 10, showing the stock of Emerson desk and ceiling fans on hand in the New York warehouse on May 4.

THE RICHMONDT ELECTRIC WIRE COMPANY writes: "We have now removed to our new factories at Waukegan, Ill., where we shall have a greatly increased output. Business in New York is very satisfactory and we propose to carry a very extensive stock here."

THE BUCKEYE ELECTRIC REPAIR WORKS, Columbus, Ohio, has built up quite an extensive business in the coal mining districts, repairing armatures, motors, transformers, etc., and has found it necessary to open a branch shop at Nelsonville, Ohio, to take care of it.

THE AMERICAN MINIATURE & DECORATIVE LAMP COMPANY, New York, has recently opened a Western branch at 254 Madison Street, Chicago, where it will be represented by Mr. A. E. Barlow. This will facilitate the business of this company to a considerable extent.

McROY CLAY WORKS have removed their Chicago office recently to 1030 Monadnock Building, where they have established comfortable and convenient Western headquarters. Mr. E. F. Kirkpatrick is in charge, and reports an excellent outlook for conduit business throughout his large territory.

ARC LAMPS.—The Fort Wayne Electric Works, Fort Wayne, Ind., in a pamphlet of recent issue illustrates and points out the principal features of the "Wood" direct-acting shunt feed series arc lamps. The various styles of these lamps are shown and many of the constituent parts are also illustrated.

THE CENTRAL ELECTRIC COMPANY, of Chicago, is distributing to the trade a price list of I. X. L. weather proof wire, double galvanized telephone wire, annunciator, office, and magnet wires and lamp cord. This company also calls attention to its well known Okonite wires and National telephone cables.

THE MEXICAN INTERNATIONAL INFORMATION & COMMISSION BUSINESS OFFICE has been organized in the City of Mexico, Mexico, to carry on the lines of business indicated by its title. The company desires to secure circulars, catalogues, discount rates, etc. Mr. H. Barron is manager, with office at Polilla, No. 5¼.

McROY BLOTTER.—The McRoy Clay Works are sending out a neat desk blotter which contains the well-known illustration of the company, showing a section of McRoy conduit supporting a heavy load of pig iron. It also contains three verses of poetry, entitled, "Have You Joined the Buffaloes?" In the lower left-hand corner is a calendar for May.

ELECTRICAL SIGNS.—A new system of making electric light signs by pegging lamps into a cork board, so that changes could be made very rapidly, was illustrated and described recently in the ELECTRICAL WORLD AND ENGINEER. The system is now in the hands of the National Electric Improvement Company, 40 Wall Street, in care of Emerson, McMillin & Co., for development.

ENGINE TYPE GENERATOR.—The Northern Electrical Manufacturing Company, Madison, Wis., has issued a bulletin illustrating and describing its 8-pole, engine type, direct-current generators. These machines are built in sizes up to 1000-kw. They are declared to be scientifically correct in design, and as far as appearances go, this claim seems to be substantiated.

THE STANDARD EQUIPMENT & MACHINERY COMPANY, of Cleveland, Ohio, recently bought out the equipment of the old power-house of the

Decatur Traction Company, Decatur, Ill., consisting of four 175-hp Ideal engines and four 65-kw T.-H. generators. The generators have been sold to the Excelsior Electric Company, Port Huron, Mich., and the East End Electric Company, Kansas City, Mo.

GOOD ADVICE.—The H. C. Roberts Electric Supply Company, 831 Arch Street, Philadelphia, Pa., in a pamphlet of recent issue tells how to keep cool and save money all summer. To attain these desirable conditions it recommends the use of Emerson desk fans. These desk fans, while keeping the atmosphere cool, it is claimed effect a saving of 20 per cent. in current for the same size fan blade and amount of air moved.

TRANSFORMERS.—The Kuhlman Electric Company, Elkhart, Ind., in a recently issued pamphlet gives some facts concerning its steel case transformers. The advantages claimed for these transformers are, close regulation, high efficiency, low core loss, and low heat. Three types of transformers are illustrated, the steel case, the oil type, and the subway type. The company manufactures transformers from 50 to 100,000 watts' capacity.

AUTOMOBILE SUPPLIES.—Mr. A. L. Dyke, Linmar Building, St. Louis, Mo., has just issued two catalogues of automobiles, parts and supplies, one No. 20 and the other No. 20A, being a supplement thereto. No. 20 contains illustrations and descriptions of automobiles built up from Dyke's automobile parts, engines, running gear, etc. The supplement, No. 20A, gives illustrations of and information about castings and working drawings of Dyke's automorette, No. 0.

CLING-SURFACE AT THE PAN-AMERICAN.—The Cling-Surface Manufacturing Company, of Buffalo, N. Y., will have a working exhibit in the machinery Building, belting section. This will consist of two similar belts running from a 10-hp motor to two similar 5-hp dynamos. One belt will be treated with cling-surface, the other will be run as it comes from the maker and run tight. The company proposes to show, in light-banks, the slack belt doing more work than the untreated tight belt.

READY DRESSED COGS.—Among useful inventions most highly prized by practical machinery men are those which facilitate the repairing of machinery when the inevitable breakdown comes. The ready dressed mill cogs of the N. P. Bowsher Company, of South Bend, Ind., possess interesting features. These cogs are ready to run as soon as driven and keyed, making it possible to fill a wheel in a few hours without taking it from the shaft. This saves both time and money as compared with the old process of renewing cogs.

"WITHIN REACH."—This is the title of a little folder issued by Harvey Hubbell, Bridgeport, Conn., illustrating the Hubbell chain pull-socket for incandescent lights, which was described and illustrated in a recent issue of the ELECTRICAL WORLD AND ENGINEER. This socket possesses many advantages which should be investigated by all users of incandescent electric lights. It matters not how far beyond reach the lights are situated, they are brought within easy reach by means of this simple device. Every light is under immediate control, irrespective of wall switches.

JOHNSON & MORTON, Utica, N. Y., the makers of the "J. & M. Standard" junction boxes, have just moved into a new factory. Their present office, storerooms and workrooms are practically four times as large as their former quarters, and in putting up their new building they have made provision for the addition of an extra floor, permitting the doubling of their capacity at a small expense and with great promptness when required. The rapid increase which their business has shown in the two years of their existence would indicate that this extra floor will soon be needed.

THE ACTINIC RAYS.—Messrs. Kliegl Brothers, 1393 Broadway, and 129 West Thirty-eighth Street, New York, have issued a pamphlet of 16 pages describing the actinolite for the production of the actinic rays and the Kliegl arc light bath. Actinic rays in the treatment of tuberculosis and skin diseases have become a recognized therapeutic agent of especial value and efficacy The actinolite is fitted with powerful lenses and is capable of producing the most intense chemical rays, which are so finely regulated as to be under complete control at all times. The pamphlet briefly discusses this branch of therapeutics in an interesting manner. Two styles of the actinolite are illustrated.

WIRT ELECTRIC COMPANY has moved its Philadelphia factory to 4523 Tacony Road, that city, where it will have two and a half times the previous floor space. It is making a considerable investment in tools and machinery, particularly in special machinery suited to its output. It is now preparing for this year's dimmer business, and will be in a position to turn out twice as much work as last year. The "Universal" type of dimmer marketed in 1900 proved so successful that it has already orders for a considerable number of them. The concern is now distributing to the trade a small pocket rule as an advertising novelty, and will be glad to send them to such electrical engineers, architects and trade houses as make application for them.

MILLING MACHINES.—The Becker-Brainard Milling Machine Company, of Hyde Park, Mass., is exhibiting in Block 44, Machinery Hall, at the Pan-American Exposition, the following distinctive types of machine tools: a No. 5B vertical spindle milling machine, driven by a direct-connected, 8-pole, variable-speed motor; a No. 5B plain horizontal milling machine in operation; a No. 14½ tool room universal milling machine; a 24-in. complete automatic geared cutter in operation, and a No. 3 cutter grinder in operation. These machines are selected to represent as fully as the limited space will permit the principal lines of tools manufacture by this company. They only give an idea of the extent and variety of designs which this company's large facilities enable it to furnish.

"A LITTLE TALK ON TALK."—General Manager Mark Davis, of the Cuyahoga Telephone Company, of Cleveland, is mailing to friends and patrons of the company an attractive little brochure entitled, "A Little Talk on Talk." It contains full illustrations of the Cuyahoga exchange and the building in which it is located, as well as the various kinds of instruments furnished by the company. The book also contains a large number of amusing parodies of popular poems adapted to the beauties of the party line, in the composition of which Mr. Davis has acquired a national reputation among independent telephone people. Among them are: "Mary Had a Little Lamb," "Yankee Doodle and the Party Line," "Comin' Through the 'Phone," "Lochinvar," "Old Oaken Bucket," etc.

GENERAL ELECTRIC COMPANY'S TRADE LITERATURE.—We have received from the General Electric Company a batch of trade literature of recent issue, which includes five price lists and two bulletins. The price lists are devoted to the following-named subjects: Parts of form 1 direct-current (series) power circuit arc lamps for 220 and 500 volts; parts of form 1 carbon feed alternating constant current (series) enclosed arc lamps; parts of carbon feed enclosed arc lamps, form 3, for alternating current multiple circuits; parts of LWP-5 motors; parts of form 3 carbon feed direct constant current (series) enclosed arc lamps. The bulletins relate to sewing machine motors and power circuit enclosed arc lamps for 220 or 550 volts. The latter bulletin is illustrated with many interior and exterior views showing the manifold uses of these lamps.

NEW BERNSTEIN LAMP.—The Bernstein Electric Manufacturing Company, 286 Roxbury Street, Boston, in a recently issued pamphlet describes a new type of incandescent lamp to which the trade name "Lowatt" has been given. The lamp includes a complete metal reflector entirely within the bulb and directly behind a multi-coiled filament, the design of the reflector being such as to utilize all of the reflecting surface in a scientific manner. One form of reflector is concave in order to concentrate the light directly below the lamp, and another is convex, in order to throw a diffused light in all directions and about equally to a point considerably above the horizontal. In still another form a concave reflector is placed at the side of the bulb. It is claimed that with this lamp there is a saving on the basis of useful light 40 to 50 per cent. in replacing ordinary 16-cp lamps.

PHILADELPHIA BRANCH OF WESTERN ELECTRIC COMPANY.—Thousands of Philadelphians were gratified on Wednesday, May 8, by the exhibit of the Western Electric Company at the new stores at 931 and 933 Market Street, Philadelphia. From an early hour until late at night visitors thronged the building, and expressions of surprise and wonderment were heard on every side. Never before in the history of this or any other electric company has there been such a display of electrical supplies of every variety, from a "Midget" push button to a dynamo of immense proportions. On the eighth floor, their guests thronged to see the finest display of talking machines that has ever been exhibited. Mr. Thomas A. Edison had sent a number of gold-plated machines of the various types so well and favorably known by users of his wonderful phonograph. The Columbia Phonograph Company also displayed some of its beautiful outfits. The Victor Gramophone came in for its share of praise and admiration, and the artistic furniture and beautifully decorated parlors of the Western Electric Company's Talking Machine Department, were a constant delight to all who witnessed the exhibition.

ELECTRICAL MEASURING INSTRUMENTS.—The Keystone Electrical Instrument Company, Ninth Street and Montgomery Avenue, Philadelphia, has favored us with a copy of its new Catalogue No. XI of Keystone standard direct-reading instruments for either direct or alternating current circuits in the switchboard and portable types. The catalogue, which contains 88 pages, is divided into eight sections. Section I relates to portable direct-reading instruments for direct-current circuits; Section II is devoted to portable direct-reading instruments for alternating-current and direct-current circuits; Section III to switchboard voltmeters and ammeters for direct-current circuits; Section IV to switchboard instruments for alternating and direct-current circuits; Section V to volt-ammeters for electric vehicles; Section VI to arc light volt meter, constant potential ground detector, polarity indicator, and detector galvanometers; Section VII gives dimensional diagrams and sample scales of switchboard instruments, and Section VIII gives directions for the selection, use and care of electrical measuring instruments and directions for ordering. The catalogue contains a good deal of information on the general subject that will be of value to the electrical engineer.

Record of Electrical Patents

UNITED STATES PATENTS, ISSUED MAY 7, 1901.

[Conducted by Wm. A. Rosenbaum, Patent Attorney, Times Bldg, N. Y.]

673,376. ELECTRICAL SIGNALING SYSTEM; H. R. Bennett, San Francisco, Calif. App. filed Aug. 9, 1900. The apparatus comprises a number of vibrating transmitting devices and an equal number of vibrating receiving devices, one of which receiving devices is capable of vibrating in synchronism with all the others.

673,381. PRINTING TELEGRAPH INSTRUMENT; L. M. Casella, London, Eng. App. filed Aug. 19, 1900. Details.

673,391. CURRENT REGULATOR; J. P. Erie, New York, N. Y. App. filed Jan. 4, 1901. A current regulator comprising a movable series of segments, a flexible band contact connected to one of the segments, and means for bringing the band into engagement with or disengaging it from the segments progressively.

673,392. RHEOSTAT SUPPORT; J. P. Erie, New York, N. Y. App. filed Sept. 13, 1900. An insulating core or support for electric conductors comprising a body portion provided with interlocking portions whereby a core is adapted to interlock with a similar core.

673,418. APPARATUS FOR USE IN WIRELESS TELEGRAPHY; J. Burry, Fort Lee, N. J. App. filed Sept. 2, 1899. One object of the present invention is to provide intervals of time in which the imperfect electrical contact shall be cut off from the collector of the oscillations or manifestations of the ether, during which time the said contacts may be restored to their normal condition of poor conductivity (or the reverse) either by self-recovery or by means appropriate to the particular kind of contact in use.

673,428. CURRENT REGULATOR; J. P. Erie, New York, N. Y. App. filed Sept. 17, 1900. This current regulator comprises a series of segments and means for electrically including a longer or shorter segment in the circuit.

673,429. LONG DISTANCE TYPEWRITER; A. J. Farmer, Detroit, Mich. App. filed June 4, 1900. Improvements in the various parts of a machine adapted for use either as a transmitting or receiving instrument.

673,441. TROLLEY BASE; F. A. Merrick and F. W. Garrett, Johnstown, Pa. App. filed Aug. 16, 1900. Details.

673,449. TELEGRAPH KEY; F. J. Raab, Toledo, Ohio. App. filed June 14, 1900. The key is in the form of a pencil, having a small push-button on the outside, which can be operated to close and open the circuit.

673,476. DEVICE EMPLOYING ELECTRIC RESISTANCE; C. Robinson, Elwood, Ind. App. filed March 15, 1900. Details of construction relating to the manner of disposing of the resistance inside of a flatiron of other electrically heated apparatus.

673,478. CONDUIT THREADER; C. B. Rodgers, Bordentown, N. J. App. filed March 15, 1901. The invention relates to the construction of the creeping shoes attached to the threader and to the method of operating the same by means of suitable cords.

673,480. APPARATUS FOR SIGNALLING BY NIGHT; L. Sellner, Vienna. Austria-Hungary. App. filed April 3, 1897. Relates to the construction of signal lanterns and to the machinery for switching the current so as to show different colors and intervals of light.

673,504. TELEPHONE SWITCHBOARD; I. J. Kusel, Chicago, Ill. App. filed Sept. 27, 1900. Details.

673,512. MICROTELEPHONIC APPARATUS; J. Berliner, Hanover, Germany. App. filed Dec. 4, 1900. The transmitter and receiver are mounted upon a single handle, which also supports switching devices to be manipulated by the user to connect and disconnect the instrument while he is using them.

673,513. SHUT OFF MECHANISM FOR ENGINES; C. F. Cowdrey, Fitchburg, Mass. App. filed Jan. 15, 1901. A steam turbine, arranged to close the stopper valve, is itself controlled by an electro-magnetic valve which admits steam to the turbine in case of emergency.

673,516. BRUSH HOLDER AND BRUSH; C. A. Eck, Newark, N. J. App. filed Nov. 24, 1900. The brush is adapted to break when it has worn to a predetermined extent and the inward movement of the spring backing up the brush is limited to avoid contact with the commutator.

673,517. BRUSH AND BRUSH HOLDER; C. A. Eck, Newark, N. J. App. filed Feb. 27, 1901. A modification of the preceding.

673,519. MULTIPLE TELEGRAPH; S. T. Foster, Jr., Laredo, Texas. App. filed March 14, 1899. Details.

673,521. MANUFACTURE OF SOLENOID OR OTHER ELECTRIC COILS; J. A. Heany, Philadelphia, Pa. App. filed Feb. 18, 1901. The wire, bare or covered, is wound upon a sheet of yielding insulating material and the spaces between the wires filled in with an insulating cement.

673,531. ELECTRIC RAILWAY CONTROLLER; E. M. Bentley, Lawrence, N. Y. App. filed June 17, 1899. The combination with two or more sets of motors and two or more series-multiple switches, of a rheostat adjustable in capacity modifying the controlling effect of all the said switches in common.

673,538. ELECTRIC RAILWAY CONDUIT; F. Hewer, Chiswick, England. App. filed June 12, 1900. Details.

673,553. APPARATUS FOR USE IN WIRELESS TELEGRAPHY; J. Burry, Fort Lee, N. J. App. filed Sept. 9, 1898. Intervals of time are provided for during which the imperfect contacts are restored to their normal condition of poor conductivity or the reverse.

673,563. SAFETY CATCH FOR INCANDESCENT ELECTRIC LAMPS; G. B. Millen, San Francisco, Cal. App. filed July 14, 1900. The catch prevents unscrewing of the lamp until it is released.

673,564. RHEOTROPE; W. Morrison, Chicago, Ill. App. filed June 18, 1900. An arrangement of contacts on a controlled cylinder.

673,565. ELECTRIC CONTROLLER; W. Morrison, Chicago, Ill. App. filed June 18, 1900. Details to avoid sparking at the contacts.

673,567. ELECTRIC TRANSFORMER; L. M. Pignolet, Orange, N. J. App. filed Sept. 10, 1898. The terminals of the section of the secondary are grouped in a peculiar manner to avoid an excessive number of soldered joints.

673,628. ELECTRO-MAGNET AND ANNUNCIATOR; C. E. Scribner, Chicago, Ill., and F. R. McBerty, of Downer's Grove, Ill. App. filed April 6, 1893. The coil is surrounded by metal of low magnetic permeability adapted to be threaded by the lines of force of the magnet; means for closing at will either current of constant direction or alternating through the magnet, whereby the pole of the magnet presented to the armature is excited only by current of constant direction.

673,652. STORAGE BATTERY CELL; J. C. Chamberlain, New York, and H. R. Sutphen, Highbridge, N. Y. App. filed Sept. 11, 1899. The cover of the cell incloses the terminals which are connected between cells by cross-pieces passing through opening in the cover.

673,656. BUSHING FOR ELECTRICAL OUTLET BOXES; H. Krantz, Brooklyn, N. Y. App. filed Feb. 9, 1901. A terminal for conduits which also acts as a connector with the walls of the outlet box.

673,660. RAIL BOND; W. T. Pringle, Landsdowne, Pa. App. filed Jan. 15, 1900. The ends of the bond are formed into tubes adapted to enter holes in the rail and be filled by a securing rivet.

673,678. STORAGE BATTERY; J. C. Chamberlain, New York, N. Y., and H. R. Sutphen, Highbridge, N. Y. App. filed Sept. 11, 1899. A group of cells in a tray are separated by insulators.

673,694. MACHINERY FOR COVERING ELECTRICAL OR OTHER WIRES FOR INSULATING PURPOSES; W. W. Colley, London, Eng. App. filed June 4, 1900. Details.

673,710. TERMINAL AND BINDING SCREW FOR ELECTRIC BATTERIES AND CONNECTIONS; W. R. Edwards, Weybridge, England. App. filed Nov. 2, 1900. Lead washers are set between the clamping faces and squeezed tightly when the connection is made, to form a packing.

673,713. SPARK DISCHARGING DEVICE FOR ELECTRIC LIGHTING FOR GAS BURNERS; P. Hoffmann, Charlottenburg, Germany. App. March 24, 1900. Details.

673,731. ELECTRIC MOTOR CONTROLLER; O. F. Shepard, Jr., Madeira, Ohio. App. filed Oct. 3, 1900. The invention consists in a controller comprising two sets of partial circuits connected, respectively, with different motor windings, means included in the partial circuits of each for inserting each set of partial circuits in its respective motor circuit, the inserting devices for one set being controlled by the devices of the other set.

673,754. PROCESS OF ELECTROLYTIC DECOMPOSITION; G. & G. W. Bell, Liverpool, Eng. App. filed June 7, 1898. (See Current News and Notes.)

673,761. PROCESS OF REDUCING SODIUM COMPOUNDS. A. H. Cowles, Cleveland, Ohio. App. filed July 20, 1895. (See Current News and Notes.)

673,765. TELLTALE FOR RAIL BONDS; J. A. Emery, Atlanta, Ga. App. filed Oct. 4, 1900. The bonds are placed behind the fish plate and a telltale wire sticks out from behind the plate to show where the bond is located.

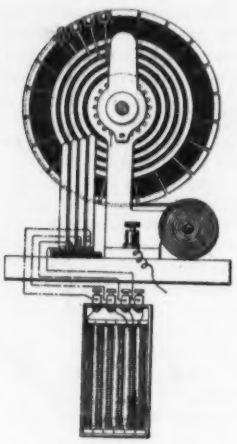
673,766. OVERHEAD TROLLEY; H. C. Eno, Pittsfield, Mass. App. filed July 7, 1900. The axle of the wheel is set in two blocks easily removable from the harp.

673,792. STORAGE BATTERY; D. W. Beebout, Pittsburg, Pa. App. filed Feb. 19, 1900. Details.

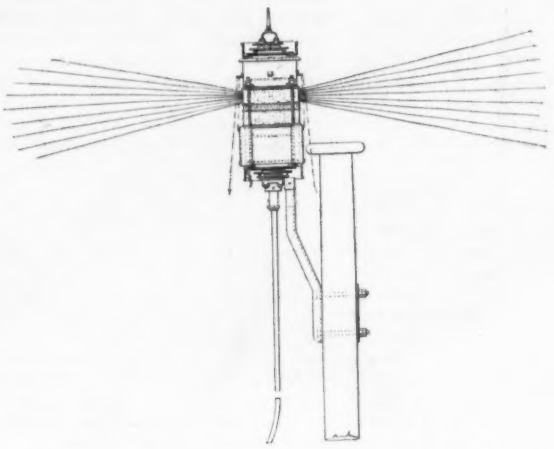
673,794. ELECTRIC SIGNAL AND TELEPHONE SYSTEM; C. L. Fortier, Milwaukee, Wis. App. filed June 12, 1899. A district telegraph and telephone system embodying a single circuit and a number of subscribers connected therein, so arranged that when one subscriber is telephoning all the others are cut out.

673,796. TELEPHONE SERVICE APPARATUS; U. S. Jackson, Ossipee, N. H. App. filed Nov. 22, 1900. Details.

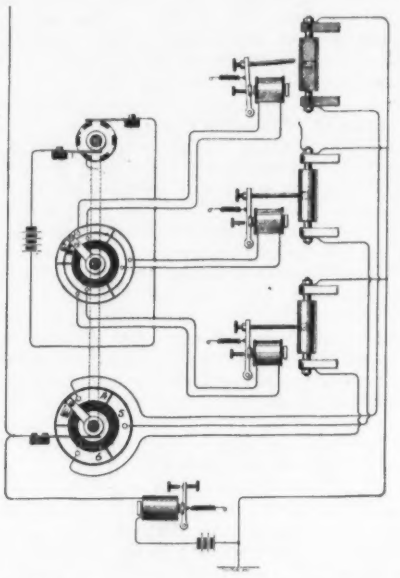
673,807. CONTROLLER FOR ROTARY TRANSFORMERS; T. S. Watson, Milwaukee, Wis. App. filed June 4, 1900. Details of construction.



673,391.—Current Regulator.



673,480.—Apparatus for Signalling by Night.



673,553.—Apparatus for Use in Wireless Telegraphy.

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